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A MONOGRAPH

OF THE

BRITISH DESMIDIACEÆ

BY

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Sub-Family II. Placodermæ.

Tribe 5. Cosmariæ.

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BRITISH DESMIDIACEÆ.

51. **Cosmarium Holmiense** Lund.

(Pl. LXV, figs. 1, 2.)

Cosmarium Holmiense Lund. Desm. Suec. 1871, p. 49, t. 2, f. 20; Nordst. Desm. Ital. 1876, p. 31; Cooke, Brit. Desm. 1886, p. 96, t. 37, f. 15; Hansg. Prodr. Algenfl. Böhm. 1888, p. 197; Boldt, Desmid. Grönland, 1888, p. 11; De Toni, Syll. Alg. 1889, p. 944; West, Alg. W. Ireland, 1892, p. 143; Roy & Biss. Scott. Desm. 1894, p. 103; Nordst. Index Desmid. 1896, p. 140; West & G. S. West, Alga-fl. Yorks. 1900, p. 80; Freshw. Alg. Orkneys and Shetlands, 1905, p. 21.
Euastrum (*Cosmarium*) *Holmiense* Gay, Monogr. loc. Conj. 1884, p. 60.
Cosmarium Holmiense a. *Lundellii* Racib. Nonn. Desm. Polon. 1885, p. 80.
C. Holmiense b. *Nordstedtii* Racib. l. c.
Ursinella Holmiensis Kuntze, Revis. gen. plant. 1891, p. 924.
Dysphinctium Holmiense (Lund.) Schmidle, Beitr. alp. Alg. 1895, p. 349.

Cells of medium size, about $1\frac{3}{4}$ times as long as broad, moderately constricted, sinus narrow and linear; semicells broadly pyramidate, basal angles slightly or considerably rounded, sides straight or slightly concave, faintly crenulate towards the apex, upper angles moderately rounded, apex broadly truncate, somewhat produced and slightly biundulate. Side view of semicell quadrate-elliptic, with a convex-truncate apex. Vertical view broadly elliptic, ratio of axes about 1 : 1·4. Cell-wall smooth or delicately punctate. Chloroplasts axile, each with one pyrenoid.

Zygospore unknown.

Length 43·2–66 μ; breadth 26·4–40 μ; breadth of isthmus 14·4–21 μ; breadth of apex 21–29 μ; thickness 19·2–28 μ.

England.—Helvellyn, Westmoreland! Not uncommon on wet rocks, W. and N. Yorks! Enbridge Lake, Hants. (*Roy*). Near the Lizard, Cornwall!

Wales.—Capel Curig (*Cooke & Wills*), and Glyder Fawr, Carnarvonshire!

Scotland.—Ross, Inverness, Aberdeen!, Kincardine, Forfar!, Perth!, Stirling, Arran (*Roy & Bissett*). Shetlands!

Ireland.—Near Oughterard, Galway! Glen Caragh, Kerry!

Geogr. Distribution.—France. Germany. Galicia. Bohemia. Poland. Italy. Norway. Sweden. Bornholm. Bosnia. Greenland. Spitzbergen. Nova Zembla. Ceylon. New Zealand. Sandwich Islands. United States. Ecuador. Argentina.

C. Holmiense is mostly an alpine and arctic species, generally occurring among mosses and various algæ on wet rocks, although it also occurs in some of the bogs and boggy rills high up on the mountains. It is usually found associated with *C. anceps* Lund., *C. galeritum* Nordst., *C. speciosum* Lund., *C. ochthodes* Nordst., and other species which have a preference for great aeration.

It is a characteristic species, being readily recognized by the dilated apex and the irregular undulation of the upper parts of the lateral margins of the semicell. In size it is very variable; the largest recorded specimen is one mentioned by Nordstedt ('Desm. Arctoæ,' 1875, p. 18) as "forma maxima" (length 98 μ; breadth 51 μ; breadth of apex 36 μ; breadth of isthmus 27 μ). From the Tyrol the same author has described a trigonal variety, in which the vertical view is trigonal with straight sides and rounded angles (*vide C. Holmiense* var. *trigonum* 'Nordst. Desm. Ital.' 1876, p. 31, t. 12, f. 6).

Var. **integrum** Lund. (Pl. LXV, figs. 3–5.)

C. Holmiense Lund. var. *integrum* Lund. Desm. Suec. 1871, p. 49; Nordst. Desm. Spetsb. 1873, p. 28, t. 6, f. 5; Hansg. Prodr. Algenfl. Böhm. 1888, p. 197; Boldt, Desmid. Grönland, 1888, p. 11; Borge, Subfoss. sötv. alg. Gotl. 1892, p. 57, t. 1, f. 10; West, Alg. Engl. Lake Distr. 1892, p. 724; Roy & Biss. Scott. Desm. 1894, p. 103; Nordst. Index Desmid. 1896, p. 140; West & G. S. West, Some Desm. U.S. 1898, p. 300; Alga-fl. Yorks. 1900, p. 80; Alg. N. Ireland, 1902, p. 32.

C. Holmiense Lund. var. Reinsch, Contrib. Alg. et Fung. 1875, p. 88, t. 12, f. 10.
Dysphinctium Holmiense (Lund.) Schmidle var. *integrum* (Lund.) Schmidle, Beitr. alp. Alg. 1895, p. 349.

Semicells a little more attenuated upwards, with the sides almost straight, and with a somewhat convex, dilated apex (neither truncate nor undulate); sinus open.

Length 45–62 μ; breadth 28–40 μ; breadth of apex 26–30 μ; breadth of isthmus 15·6–22 μ; thickness 24–28 μ.

England.—Near Bowness (*Bissett*), and Helvellyn!, Westmoreland. Cumberland! Malham Tarn, bog near Clapham, Arncliffe, and Penyghent, W. Yorks! Mickle Fell, and Mossdale Moor, Widdale Fell, N. Yorks! Chippenham Fen, Cambridgeshire!

Wales.—Moel Siabod, Snowdon, and Glyder Fawr, Carnarvonshire!

Scotland.—Glen Urquhart; Cromar and Upper Deeside, Aberdeen; Lundie and Reeky Linn, Forfar (*Roy & Bissett*). Clova Mts., Forfar! Glen Shee and Craig-an-Lochan, Perth! Inverness (and in Skye)! Sutherland! Outer Hebrides!

Ireland.—Shores of Lough Neagh! Mourne Mts., Down! Achill Is., Mayo! Carrantuohill, Kerry!

Geogr. Distribution.—Austria. Galicia. Germany. Switzerland. Faeroes. Norway. Sweden. Spitzbergen. Nova Zembla. United States.

This variety is more widely distributed and somewhat more abundant than the typical form. It occurs in similar situations, and is frequently found among the luxuriant Myxophyceous growth covering the wet and dripping rocks of the mountain ghylls and glens. It differs from the type in the convex apices, the absence of the small undulations from the upper parts of the sides of the semicells, and in the open sinus.

C. holmiense var. *integrum* is not unlike *C. quadratum*, but the semicells are more attenuated upwards, and the apex is dilated and more convex in the centre. It should also be compared with *C. integerrimum* Näg. ('Gatt. einz. Alg.' 1849, p. 119, t. 7, f. A. 1).

Var. **attenuatum** Gutw. (Pl. LXV, fig. 6.)

C. Holmiense Lund. var. *attenuatum* Gutw. Wahr. d. Priorität, 1890, p. 67; Flor. Glon. Okolic Lwowa, 1891, p. 43, t. 1, f. 18.
C. Holmiense Lund. var. *integrum* Lund. forma West, Alg. Engl. Lake Distr. 1892, p. 724, t. 9, f. 12.

Semicells strongly attenuated upwards, with a prominent constriction below the apex; apex narrower than in var. *integrum* and very slightly triundulate. Side view of semicell more attenuated. Vertical view often narrower with slightly produced poles.

Length 52–60 μ; breadth 30–36 μ; breadth of apex 21–22 μ; breadth of isthmus 16–22 μ; thickness 17·5–29 μ.

England.—Brothers' Water, Westmorland!

Geogr. Distribution.—Galicia in Austria.

This variety does not appear to be a very constant one, and is connected by intermediate forms with var. *integrum* Lund. The sides of the semicells may be as in the latter variety or they may be somewhat irregularly undulate. The cells vary much in relative thickness.

Var. **undatum** West & G. S. West. (Pl. LXV, fig. 7.)

C. Holmiense Lund. var. *undatum* West & G. S. West, New Brit. Freshw. Alg. 1894, p. 5, t. 1, f. 12.

Cells smaller than in the type, with truncate-pyramidate semicells and triundulate sides; cell-wall very delicately punctate.

Length 56 μ; breadth 34 μ; breadth of isthmus 13 μ; thickness 27 μ.

Scotland.—Glen Shee, Perthshire!

This variety should possibly be referred elsewhere. We have only observed it once, and before removing it from *C. Holmiense* we should like to examine further specimens.

Note.—The "var. *minor* Arch." referred to in Cooke's 'British Desmids,' p. 97, and mentioned by Archer in 'Micr. Journ.' xvi, 1876, p. 344, is only a small form of the species probably referable to var. *integrum* Lund.

52. **Cosmarium cymatopleurum** Nordst.

(Pl. LXV, figs. 8, 9.)

Cosmarium cymatopleurum Nordst. Desm. Spetsb. 1872, p. 28, t. 6, f. 4; Desm. Arctoæ, 1875, p. 18; Cooke, Brit. Desm. 1887, p. 188, t. 66, f. 3; De Toni, Syll. Alg. 1889, p. 970; West, Alg. Engl. Lake Distr., 1892, p. 724; Lütkem. Desm. Attersees, 1893, p. 556; Nordst. Index Desmid. 1896, p. 96; West & G. S. West, Alga-fl. Yorks. 1900, p. 80.
C. cymatopleurum forma *polonica* Racib. Desm. Nowe, 1889, p. 87, t. 5, f. 36.
Ursinella cymatopleura Kuntze, Revis. gen. plant. 1891, p. 924.

Cells large, about $1\frac{1}{3}$ times longer than broad, deeply constricted, sinus very narrow with a dilated apex, opening outwards; semicells truncate-pyramidate, from a subreniform base converging upwards, sides almost straight and very slightly undulate, upper angles obtuse, apex very slightly produced, convexly truncate, sometimes delicately undulate. Side view of semicell elliptic-circular. Vertical view elliptic, poles bluntly pointed (rarely rounded), with three parallel series of undulations (interrupted in the middle) more or less distinctly visible within each lateral margin, ratio of axes about 1 : 1·66. Cell-wall rather thick and finely punctate, often becoming yellow. Chloroplasts axile, each with two pyrenoids.

Zygospore unknown.

Length 82–97 μ; breadth 60–70 μ; breadth of apex 25–38 μ; breadth of isthmus 25–30 μ; thickness 40–43 μ; thickness of cell-wall 2–2·5 μ.

England.—Near Bowness, Westmoreland! Penyghent, W. Yorks! Mickle Fell, N. Yorks!

Geogr. Distribution.—Austria. Galicia. Poland. Finland. Spitzbergen. Nova Zembla.

C. cymatopleurum and its varieties are essentially Alpine Desmids, occurring amongst mosses on dripping rocks associated with *C. Holmiense, C. anceps, C. speciosum, C. Etchachanense, Staurastrum acarides,* etc. These species are also associated in boggy mountain springs, but *C. cymatopleurum* is perhaps the rarest of them and is only occasionally found.

Var. **Tyrolicum** Nordst. (Pl. LXV, figs. 11, 12.)

C. cymatopleurum Nordst. var. *Tyrolicum* Nordst. Desm. Ital. 1876, p. 30, t. 12, f. 5; De Toni, Syll. Alg. 1889, p. 970; West, Alg. Engl. Lake Distr., 1892, p. 724; Roy & Biss. Scott. Desm. 1894, p. 44; West & G. S. West, Alga-fl. Yorks. 1900, p. 80; Alg. N. Ireland, 1902, p. 37.
C. subochthodes Schmidle, Weit. Beitr. Algenfl. Rheineb. u. Schwarzwald. 1895, p. 75, cum. fig. 26 *a–c*.

Slightly larger than the type; semicells subelliptic, the whole margin slightly undulate, basal angles less rounded; apex not truncate; cell-wall more distinctly punctate.

Length 80–108 μ; breadth 68–77 μ; breadth of isthmus 22–36 μ; thickness 47–50 μ.

England.—Hawkshead, Lancashire! Shipley Glen, on wet rocks near Arncliffe, and Penyghent, W. Yorks! Lund's Fell, N. Yorks! Tremethick Moor, Cornwall!

Scotland.—Near Aboyne and Corrie of Loch Kandor, Aberdeen; Canlochan (associated with var. *Archerii*), Forfar! (*Roy & Bissett*). Rhiconich, Sutherland!

Ireland.—Bog near Lough Neagh, Londonderry! Lough Shannacloontippen, Galway! Kenmare, Kerry!

Geogr. Distribution.—Germany. Italy.

This variety is more frequently found than typical *C. cymatopleurum*, and sometimes occurs in pure masses, forming a pale green, gelatinous stratum on dripping rocks in the more sheltered parts of rocky glens. *C. microsphinctum* is sometimes found amongst it.

It differs from typical *C. cymatopleurum* in its more inflated semicells, without a produced apex, and in the more uniform undulation of the lateral margins. The cell-wall is also more strongly punctate. When occurring in gelatinous masses an exuviation of the outer layers of the cell-wall into the surrounding mucus can be sometimes observed.

Var. **Archerii** (Roy & Biss.) West & G. S. West. (Pl. LXV, fig. 10.)

Cosmarium Archerii Roy & Biss. Scott. Desm. 1894, p. 42, t. 1, f. 5.
C. cymatopleurum Nordst. var. *Archerii* (Roy & Biss.) West & G. S. West, Notes Alg. II, 1900, p. 291, t. 412, f. 5; Alga-fl. Yorks. 1900, p. 80.

Slightly larger than the type, apex of semicells still more produced, and undulations of lateral margins more pronounced, vertical view with blunter poles.

Length 91–112 μ; breadth 67–87 μ; breadth of apex 33–38 μ; breadth of isthmus 24–35 μ.

England.—Penyghent, W. Yorks!

Scotland.—Glen Callater, beside the "Break Neck" Waterfall, Aberdeen; Canlochan, Forfar! (*Roy & Bissett*). North shore of Loch Tay, Perth (*Archer*).

Geogr. Distribution.—Galicia (a form). Finland.

The produced apices of this variety give it a rather remarkable appearance, but this feature is not sufficient to warrant its separation by Messrs. Roy and Bissett as a distinct species. The specimens observed from West Yorkshire were intermediate between the typical form and var. *Archerii* with regard to the extension of the produced apices. The occurrence of intermediate forms of this nature (*vide* Pl. LXV, fig. 9) is sufficient to show that these plants are forms of one species.

53. **Cosmarium obtusatum** Schmidle.

(Pl. LXV, figs. 13, 14.)

? *Cosmarium ochthodes* Nordst. var. *obtusatum* Gutw. Wahr. d. Priorität, 1890, p. 68; Flor. Glon. Okolic Lwowa, 1891, p. 51, t. 2, f. 3.
C. undulatum Corda var. *obtusatum* Schmidle, Alg. Geb. Oberrheins, 1893, p. 550, t. 28, f. 11.
C. obtusatum Schmidle, Ost-Africa Desmid. 1898, p. 38; West & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 21.

Cells of medium size, about $1\frac{1}{6}$ times as long as broad, deeply constricted, sinus very narrow with dilated apex; semicells truncate-pyramidate, basal angles slightly rounded, sides convex with about 8 undulations, also with two similar series within each margin having an appearance not unlike granules, apex truncate. Side view of semicell broadly elliptic. Vertical view oblong-elliptic, ratio of axes about 1 : 2, poles undulate; with four or five short parallel series of undulations within each pole. Cell-wall punctate. Chloroplasts axile, each with two pyrenoids.

Zygospore unknown.

Length 48–60 μ; breadth 42–50 μ; breadth of isthmus 15–15·5 μ; thickness 22 μ.

Scotland.—Plankton of Loch Asta, Shetlands!

Geogr. Distribution.—Germany. Galicia in Austria (?). E. Africa.

The Scottish specimens possessed rather smaller apices than those described by Schmidle, but were otherwise precisely similar.

C. obtusatum is nearly allied to *C. cymatopleurum* var. *tyrolicum*, from which it is distinguished by its somewhat smaller size, its deeper constriction, its truncate apex, and its much thinner cell-wall. In outward appearance it has a certain resemblance to some forms of *C. ochthodes*, but it is smaller, and the surface-markings are of quite a different character.

Var. **Beanlandii** *nob.* (Pl. LXV, fig. 15.)

Cosmarium subundulatum Wille var. *Beanlandii* West & G. S. West, New Brit. Freshw. Alg. 1894, p. 7, t. 1, f. 10.

Cells longer than in the typical form, $1\frac{1}{4}$–$1\frac{1}{2}$ times as long as broad, apices subtruncate and sometimes subretuse, margin of semicells with about 18 undulations.

Length 65–85 μ; breadth 55–59 μ; breadth of isthmus 20·5–22 μ; thickness 33 μ.

England.—Newsholme, E. Yorks!

This variety resembles several of the forms of *C. speciosum* Lund., but is more deeply constricted than any of them, and has no granules within the margin of the semicells. The cells are also proportionately shorter. Compare with *C. speciosum* Lund. var. *simplex* Nordst. ('Desm. Spetsb.' 1872, p. 31, t. 6, f. 12) and *C. speciosum* var. *australianum* Nordst. ('Freshw. Alg. N. Zeal.' 1888, p. 79, t. 5, f. 9).

54. **Cosmarium venustum** (Bréb.) Arch. (Pl. LXVI, fig. 1–3.)

Euastrum venustum Bréb. Liste Desm. 1856, p. 124, t. 1, f. 3; Cooke, Brit. Desm. 1886, p. 77, t. 35, f. 11; West, Alg. N. Wales, 1890, p. 288.

Cosmarium venustum (Bréb.) Arch. in Pritch. Infus. 1861, p. 732; Rabenh. Flor. Europ. Alg. III, 1868, p. 164; Kirchn. Alg. Schles. 1878,

p. 149; Hansg. Prodr. Algenfl. Böhm. 1888, p. 196; De Toni, Syll. Algar. 1889, p. 946; West, Alg. W. Ireland, 1892, p. 147; Alg. Engl. Lake Distr. 1892, p. 726; Lütkem. Desm. Attersees, 1893, p. 550; Roy & Biss. Scott. Desm. 1894, p. 177; Nordst. Index Desmid. 1896, p. 268; West & G. S. West, Alg. S. England, 1897, p. 487; Lütkem. Desm. Millstättersees, 1900, p. 12; West & G. S. West, Alga-fl. Yorks. 1900, p. 82; Alg. N. Ireland, 1902, p. 35; Freshw. Alg. Orkneys and Shetlands, 1905, p. 21.

? *Didymidium* (*Cosmarium*) *Braunii* Reinsch, Algenfl. Frank. 1867, p. 114, t. 10, f. 3 [in part; *b* and *e*?]

Cosmarium Cambricum Cooke & Wills in Grevillea, 1880, p. 91; Cooke, Some Desm. New to Britain, 1881, t. 13, f. A b; Lagerh. Bidr. Amerik. Desm.-fl. 1885, p. 241; Cooke, Brit. Desm. 1887, p. 98, t. 42, f. 16; De Toni, Syll. Algar. 1889, p. 957.

C. Cambricum a. *typicum* Racib. Nonn. Desm. Polon. 1885, p. 79.

Ursinella venusta Kuntze, Rev. gen. plant. 1891, p. 926.

U. Cambrica Kuntze, l. c. p. 924.

Cells rather small, about $1\frac{1}{4}$ times longer than broad, very deeply constricted, sinus narrowly linear with a dilated apex; semicells truncate-pyramidate, sides (including the rounded upper and lower angles) triundulate, apex widely truncate and generally slightly retuse (more rarely straight). Side view of semicell elliptic. Vertical view elliptic, ratio of axes about 1 : 1·8. Cell-wall minutely punctate. Chloroplasts axile with one central pyrenoid.

Zygospore unknown.

Length 32·6–42 μ; breadth 22–32·5 μ; breadth of isthmus 5·7–13·4 μ; thickness 12–19 μ.

England.—Cumberland! Westmoreland! (*Bissett*). Lancashire! W. N. and E. Yorks! Hants! Devon! Cornwall!

Wales.—Capel Curig! (*Cooke & Wills*), Moel Siabod!, Yr Orsedd!, and Y Foel Fras!, Carnarvonshire.

Scotland.—General! (*Roy & Bissett*). Outer Hebrides! Orkneys! Shetlands!

Ireland.—Donegal! Mayo! Galway! Kerry! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Austria. Galicia. Norway. Sweden. Denmark. Finland. Poland. Russian Lapland. S. Russia. Faeroes. Nova Zembla. Greenland. Siberia. India. Sumatra (form). Java. Australia. Azores. United States. Paraguay.

C. venustum is a characteristic species which exhibits some variation in the relative prominence of the lateral undulations, in the degree of rotundity of the basal angles of the semicells, and in the width of the isthmus. It occurs most abundantly in the upland Sphagnum-pools. Nordstedt has described and figured a trigonal variety of it ("β *trigonum*") from Russian Lapland (*vide* 'Desmid. Arctoæ,' 1875, p. 41, t. 8, f. 42).

It is impossible to draw a distinction between *C. venustum* and *C. Cambricum*, as the undulation of the sides of the semicells varies much in specimens even from the same locality.

Forma **minor** Wille. (Pl. LXVI, fig. 4.)

C. venustum ? forma *minor* Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 43; Boldt, Siber. Chlorophy. 1885, p. 104, t. 5, f. 10; West, Alg. W. Ireland, 1892, p. 147; Schmidle, Alg. aus Sumatra, 1895, p. 302; West & G. S. West, Alg. N. Ireland, 1902, p. 35.

C. Cambricum Cooke & Wills forma *minor* Turn. Freshw. Alg. E. India, 1893, p. 70, t. 10, f. 15.

About two-thirds the size of the type.

Length 20–25 μ; breadth 16–18 μ; breadth of isthmus 6–7 μ.

Scotland.—Ben Lawers, Perth!

Ireland.—Ballynahinch and Athry Lough, Galway! Gortahork, Donegal!

Geogr. Distribution.—Germany. Nova Zembla. Siberia. India. Sumatra.

Lundell ('Desm. Suec.' 1871, p. 23) records the occurrence of a fragile chain of seven individuals of a small form of *C. venustum*.

There is little doubt that *C. Cambricum* var. *dubium* Racib. ('Nonn. Desm. Polon.' 1885, p. 79, t. 11, f. 10) is a minute form of *C. venustum* which is only about half the size of Wille's forma *minor*.

Var. **hypohexagonum** West. (Pl. LXVI, figs. 5, 6.)

C. venustum var. *hypohexagonum* West, Alg. W. Ireland, 1892, p. 147, t. 21, f. 1; Alg. Engl. Lake Distr. 1892, p. 726.

C. venustum var. *hypohexagonum* forma *incrassata* West, Alg. W. Ireland, 1892, p. 147, t. 24, f. 23.

Sides of semicells tricrenate rather than triundulate,

the cell-wall being thickened at the base of the incisions.

Length 25–38 μ; breadth 20–25 μ; breadth of isthmus 5–8·5 μ; thickness 11–16 μ.

England.—Kirk Fell, Cumberland! Near Stickle Tarn, Westmoreland!

Wales.—Llyn-y-cwm-ffynon, Carnarvonshire!

Ireland.—Ballynahinch and Athry Lough, Galway!

Geogr. Distribution.—Australia.

The sides of the semicells of this variety are tricrenate, and at the base of each of the incisions the cell-wall is thickened. This is best seen when the cell is slightly oblique. The form described from the West of Ireland as "forma *incrassata*" differs only in size and is therefore included in the description of var. *hypochondrum*. Borge has suggested (in 'Nuova Notarisia,' 1894, p. 21) that this variety does not belong to *C. venustum*, but we think it much too near that species to be separated from it.

Var. **majus** Wittr. (Pl. XCII, fig. 2.)

Euastrum venustum var. *majus* Wittr. Skandinav. Desm. 1869, p. 7, t. 1, f. 1.

Cosmarium venustum var. *majus* Wittr.; Roy. & Biss. Scott. Desm. 1894, p. 77; West, Alg. S. England, 1897, p. 487; West & G. S. West, Alg. N. Ireland, 1902, p. 35; Freshw. Alg. Orkneys and Shetlands, 1905, p. 21.

A large variety with three-lobed semicells; lateral lobes subquadrate with rounded angles and straight or slightly retuse sides, polar lobe more widely subquadrate with rounded angles and retuse apex.

Length 57 μ; breadth 41 μ; breadth of apex (polar lobe) 25 μ; breadth of isthmus 9·5 μ.

England.—New Forest, Hants! Thursley Common, Surrey!

Wales.—Radnor!

Scotland.—Strathpeffer, Ross; Upper Powlair in Birse, Aberdeen; Dalbrake, and Bogandreep in Strachan, Kincardine; Glen Clova and Clova Tableland, Forfar; Folotry Loch in Fowlis Wester, Perth; near Kingshouse, Argyll (*Roy & Bissett*). Scalloway, Shetlands!

IRELAND.—Errigal, Donegal!
Geogr. Distribution.—Norway. Sweden.

55. **Cosmarium Garrolense** Roy & Biss.
(Pl. LXVI, figs. 7, 8.)

Cosmarium Garrolense Roy & Biss. Scott. Desm. 1894, p. 101, t. 2, f. 4; Schmidle, Beitr. alp. Alg. 1895, p. 351.
C. latereundatum Roy & Biss. MS. l.c., p. 101 [name only].
C. alpinum (Racib.) De Toni var. *Helveticum* Schmidle, Alg. Bern. Alp. 1894, p. 89, t. 6, f. 11 [*vide* West & G. S. West in Journ. Bot. Mar. 1895, p. 67].
C. alpinum (Racib.) De Toni var. *Garrolense* (Roy & Biss.) Schmidle in Nuova Notarisia, 1897, p. 66; Lappmark Süsswasseralgen, 1898, p. 41.

Cells rather small, $1\frac{1}{6}$ times longer than broad, deeply constricted, sinus very narrow with a dilated apex; semicells truncate-pyramidate, sides upwardly converging and slightly convex, with three to five equal undulations, apex widely truncate but distinctly convex (sometimes obscurely plicated). Side view of semicell subcircular. Vertical view elliptic, ratio of axes about 1 : 1·6. Cell-wall sparsely and delicately punctate.

Zygospore unknown.

Length 27–31 μ; breadth 20–25 μ; breadth of isthmus 9–11 μ.

ENGLAND.—Near Ambleside, Westmoreland!

SCOTLAND.—Den of Garrol, Kincardine; Clova Tableland, Forfar! (*Roy & Bissett*).

Geogr. Distribution.—Germany. Switzerland. N. Sweden.

We have already shown that *C. alpinum* (Racib.) De Toni is without doubt a small form of *C. undulatum* Corda, being identical in size and general outline with *C. undulatum* var. *minutum* Wittr. (*vide* vol. ii, pp. 149–150). *C. Garrolense* Roy & Biss. differs from the latter in its widely truncate apex which is without undulations.

56. **Cosmarium Reinschii** Arch.
(Pl. LXVI, figs. 9, 10.)

Cosmarium sp. Reinsch, Contrib. Alg. et Fung. 1875, p. 83, t. 18, f. 4.
C. Reinschii Arch. in Quart. Journ. Micr. Sci., 1876, n.s. vol. vi, p. 109;

Cooke, Brit. Desm. 1886, p. 96, t. 37, f. 14 [figure bad]; De Toni, Syll. Algar. 1889, p. 1045; Roy & Biss. Scott. Desm. 1894, p. 173; Nordst. Index Desm. 1896, p. 223; West & G. S. West, Freshw. Chlorophy. Koh Chang, 1901, p. 90.
Ursinella Reinschii Kuntze, Revis. gen. plant. 1891, p. 925.

Cells rather small, about $1\frac{1}{5}$ times longer than broad, very deeply constricted, sinus narrowly linear with a dilated apex; semicells truncate-pyramidate, basal angles rounded, sides convex with about 4 acute undulations (slightly increasing in size towards the apex), apex slightly produced and broadly truncate, upper angles not rounded or very slightly so. Side view of semicell subcircular. Vertical view elliptic, with a rounded inflation at the middle on each side, ratio of axes about 1 : 1·7. Cell-wall minutely punctate.

Zygospore unknown.

Length 36–37 μ; breadth 27·5–30 μ; breadth of isthmus 7–8 μ; thickness 15–16 μ.

England.—Cornwall (*Cooke*).

Scotland.—Folotry, Perth (*Roy & Bissett*). Clova Mts., Forfar!

Ireland.—Westmeath (*Archer*).

Geogr. Distribution.—Germany. Siam. Australia. United States.

C. Reinschii Arch. is a rare species which has very seldom been observed. Nordstedt, in his 'Index Desmid.' 1896, p. 1858, states that *C. limnophilum* Schmidle is synonymous with *C. Reinschii* Arch. but the few specimens we have seen of the latter species do not possess the granulation described and figured by Schmidle for *C. limnophilum* (*vide* Schmidle, 'Beitr. alp. Alg.,' 1895, p. 457, t. 15, f. 20).

Var. **eboracense** *var. nov.* (Pl. LXVI, fig. 11.)

Sides of semicells with five undulations, those near the basal angles being much smaller than the upper ones, apex truncate with two shallow undulations, apical angles not rounded. Vertical view broadly elliptic, without a median inflation.

Length 32–36 μ; breadth 24–25 μ; breadth of isthmus 9–11·5 μ; thickness 8 μ.

England.—Penyghent, W. Yorks!

57. **Cosmarium Nägelianum** Bréb.

(Pl. LXVI, fig. 12.)

Euastrum (*Cosmarium*) *crenatum* Näg. Gatt. einz. Alg. 1849, p. 120, t. 7 A, f. 8; Gay, Monogr. loc. Conj. 1884, p. 61.

Cosmarium Nägelianum Bréb. Liste Desm. 1856, p. 127; Arch. in Pritch. Infus. 1861, p. 732; Rabenh. Flor. Europ. Alg. III, 1868, p. 164; Hansg. Prodr. Algenfl. Böhm. 1888, p. 196; Kirchner, Nachtr. Alg. Württ. 1888, p. 154; De Toni, Syll. Alg. 1889, p. 942; Heimerl, Desm. Alp. 1891, p. 599; Gutw. Flor. glonów Galic. 1892, p. 126; Lütkem Desm. Attersees, 1893, p. 553; Schmidle, Beitr. Algenfl. Schwarzwald u. Rheineb. 1893, p. 30; Roy & Biss. Scott. Desm. 1894, p. 169; Börg. Freshw. Alg. Færöes, 1901, p. 227.

Ursinella Nägeliana Kuntze, Revis. gen. plant. 1891, p. 925.

Cells small, about $1\frac{1}{3}$ times longer than broad, very deeply constricted, sinus narrowly linear; semicells truncate-pyramidate, basal angles rectangular or obliquely truncate, sides with three undulations, upper angles acute or subacute, apex straight or very slightly biundulate. Vertical view elliptical. Cell-wall sparsely punctate.

Zygospore . . . ?

Length 26–30 μ; breadth 19–22·5 μ; breadth of isthmus 6–8 μ; thickness 10–? μ.

Scotland.—Springhill near Aberdeen, and pool near Loch Dawin, Aberdeen; near Cowie, Kincardine (*Roy & Bissett*).

Ireland.—Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Austria. Galicia. Italy. Norway. Sweden. Faeroes. New Zealand. Australia. E. Africa. United States. Brazil.

We have never examined any plants of this genus corresponding exactly with Nägeli's figures of "*Euastrum* (*Cosmarium*) *crenatum*," and we are in some doubt as to the exact characters of the vertical view. The Desmid issued as "*C. Nägelianum* Bréb. forma" in Nordstedt, Wittrock, and Lagerheim, 'Alg. Exsic.' 1894, no. 1276, and determined by Prof. W. Schmidle, we do not consider to belong to that

species, and in this we are supported by the opinion of Dr. Nordstedt. Roy and Bissett record the plant as very rare in Scotland, but we are only able to give an incomplete description of it and a copy of Nägeli's figures.

Kirchner has described the zygospore of what he considered to be *C. Nägelianum* (Consult 'Kirchn. Nachträge zur Algenfl. Württemb.' Württ. Naturwiss. Jahr. 44, 1888, p. 154). He describes it as globose, with short processes each furnished with two or three short spines, at the same time remarking that it is like that of *C. crenatum* Ralfs. This description also fits the zygospore of *C. notabile* Bréb. It is very probable that *C. Nägelianum* is only a form of *C. notabile*.

Maskell has figured the zygospore of a New Zealand variety of it (var. *latum* Mask.), which is globose and covered with short simple spines (*vide* Mask. 'Further Notes N. Zeal. Desm.' 1889, p. 17, t. 3, f. 27). Whatever Maskell's New Zealand plant may be, it is certainly not referable to the same species as "*Euastrum* (*Cosmarium*) *crenatum* Näg."

We have for some time past regarded *C. orthogonum* Delp. as merely a variety of *C. Nägelianum* Bréb., and this may prove to be the case, but as Delponte's species, although very rare, appears to be the better known of the two, we think it advisable in the present state of our knowledge to consider it separately. A full description of *C. orthogonum* is given in the appendix to this division of the genus *Cosmarium*.

58. **Cosmarium notabile** Bréb.

(Pl. LXVI, figs. 15, 16.)

Cosmarium notabile Bréb. Liste Desm. 1856, p. 129, t. 1, f. 15; De Bary, Conj. 1858, t. 6, f. 53, 53; Arch. in Pritch. Infus. 1861, p. 733; Rabenh. Flor. Europ. Alg. III, 1868, p. 173; Kirchn. Alg. Schles. 1878, p. 152; Wolle, Desm. U.S. 1884, p. 66, 79, t. 16, f. 11; Roy & Biss. Scott. Desm. 1894, p. 169; Nordst. Index Desmid. 1896, p. 183; West & G. S. West, Alg. S. England, 1897, p. 488; Alga-fl. Yorks. 1900, p. 81; Alg. N. Ireland, 1902, p. 37; Freshw. Alg. Orkneys and Shetlands, 1905, p. 21.
Didymidium (*Cosmarium*) *notabile* Reinsch, Algenfl. Frank. 1867, p. 117.
Penium (*Sphinctopenium*) *notabile* Gay, Monogr. loc. Conj. 1884, p. 71.
Dysphinctium notabile (Bréb.) Hansg. in Oesterr. botan. Zeitschr. 1887, xxxvii, p. 57; Prodr. Algenfl. Böhm. 1888, p. 186; De Toni, Syll. Alg. 1889, p. 889. Gutw. Flor. glonów Galic. 1892, p. 123; Schmidle, Beitr. alp. Alg. 1895, p. 348.

Cells rather small, from $1\frac{1}{3}$ to $1\frac{1}{2}$ times as long as broad, moderately constricted, sinus narrow and generally open; semicells truncate-pyramidate, basal angles rectangular and slightly rounded, apical angles

slightly rounded, sides slightly convex with three undulations between the basal and apical angles, apex truncate and biundulate (sometimes very obscurely). Side view of semicell semi-oblong-elliptic. Vertical view subelliptic, ratio of axes about 1 : 1·5. Cell-wall smooth. Chloroplasts axile, each with one pyrenoid and several longitudinal ridges.

Zygospore globose, bearing many short stout spines (almost verrucæ), slightly dilated at the base and bi- or trifurcate at the apex.

Length 28–34·5 μ; breadth 19–25·3 μ; breadth of isthmus 8–16 μ; thickness 14–17 μ; diam. zygosp. without spines 25–26 μ, with spines 35–36·5 μ.

England.—Ogden Clough, Ribblehead, and Cam Fell (with zygospores), W. Yorks! Leicestershire (*Roy*). Tintagel and Withiel, Cornwall!

Wales.—Radnor!

Scotland.—Inverness, Aberdeen, Kincardine, Forfar, Perth!, Argyll (*Roy & Bissett*). Bressay, Shetlands! Orkneys!

Ireland.—Slievecommedagh, Down! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Galicia. Bohemia (var.). Italy. Norway. Sweden (var.). Bosnia. Nova Zembla. Franz-Joseph-Land. Greenland. E. Africa. Azores. United States.

C. notabile is a rare species occurring in boggy mountain springs, in the permanent bogs of heaths, and not uncommonly among mosses on rocks kept constantly wet by trickling water. The width of the isthmus is somewhat variable, but in all specimens of the typical plant the sinus is slightly open. The zygospores we have examined from West Yorkshire are very similar to those of *C. crenatum*, and differ from the zygospore of this species figured by De Bary ('Conj.' 1858, t. 6, f. 54) in the possession of much more robust spines without any marked basal inflation.

Forma **minor** Wille. (Pl. LXVI, fig. 17.)

C. notabile Bréb. forma *minor* Wille, Ferskw. Alg. Nov. Semlj. 1879, p. 36, t. 12, f. 17; Cooke, Brit. Desm. 1887, p. 118, t. 42, f. 12; De Toni, Syll.

Alg. 1889, p. 890 ["forma *minus*"]; West, Alg. N. Yorks. 1889, p. 293; Gutw. Flor. Glonów Galic. 1892, p. 14; Roy & Biss. Scott. Desm. 1894, p. 169; West & G. S. West, Alga-fl. Yorks. 1900, p. 81.

Dysphinctium notabile (Bréb.) Hansg. forma *minor* (Wille) Schmidle, Weit. Beitr. Algenfl. Rheineb. u. Schwarzwald. 1895, p. 72.

A small form somewhat less constricted, with slightly more convex sides and truncate apices.

Length 24–30 μ; breadth 15–20 μ; breadth of isthmus 12–16 μ; thickness 15–18 μ.

England.—Mickle Fell, N. Yorks!

Scotland.—Craig-an-Lochan, Perth!

Ireland.—Near Westport, Mayo!

Geogr. Distribution.—Germany. Bohemia and Galicia in Austria. Nova Zembla.

Forma **media** Gutw. (Pl. LXVI, figs. 18, 19.)

C. notabile Bréb. forma *media* Gutw. Wahr. d. Prioritat, 1890, p. 66; Flora Glon. Okolic Lwowa, 1891, p. 39, t. 1, f. 10; West & G. S. West, Alg. S. England, 1897, p. 488.

Sinus somewhat more closed than in the type; vertical view slightly tumid at the middle on each side.

Length 25–36 μ; breadth 16–24 μ; breadth of isthmus 9–12 μ; thickness 13–17 μ.

England.—New Forest, Hants!

Geogr. Distribution.—Galicia in Austria.

Gutwinski states that this form also differs in having more rounded apices when seen in the side view, but we find the apices of the type-form to be commonly rounded when seen from the side.

59. **Cosmarium tetragonum** (Näg.) Arch. (Pl. LXVI, figs. 20, 21.)

Euastrum (*Cosmarium*) *tetragonum* Näg. Gatt. einz. Alg. 1849, p. 119, t. 7 A, f. 5.

Cosmarium tetragonum (Näg.) Arch. in Pritch. Infus. 1861, p. 732; Rabenh. Flor. Europ. Alg. III, 1868, p. 164; Cooke, Brit. Desm. 1887, p. 98, t. 37, f. 17; De Toni, Syll. Alg. 1889, p. 959; West, Alg. N. Yorks. 1889, p. 292; Alg. N. Wales, 1890, p. 289; Alg. Engl. Lake Distr. 1892, p. 724; Roy & Biss. Scott. Desm. 1894, p. 176; Nordst. Index Desmid. 1896, p. 253; West & G. S. West, Alg. S. England, 1897, p. 485; Alga-fl. Yorks. 1900, p. 81.

Ursinella tetragona Kuntze, Revis. gen. plant. 1891, p. 925.

Cells rather small, about twice as long as broad, deeply constricted, sinus narrowly linear, with a slightly

dilated apex; semicells subquadrate, slightly narrowed from base to apex, sides (including the angles) 4-undulate, upper and lower angles slightly rounded, apex with two undulations. Side view of semicell subelliptic. Vertical view elliptic, ratio of axes about 1 : 1·6. Cell-wall smooth. One axile chloroplast in each semicell containing a central pyrenoid.

Zygospore unknown.

Length 35–45 μ; breadth 21·5–25 μ; breadth of isthmus 9–12 μ; thickness 16–18 μ.

England.—Bowness, Westmoreland (*Bissett*). Near Ilkley and Penyghent, W. Yorks! Mickle Fell, N. Yorks! Epping Forest, Essex!

Wales.—Bettwys-y-Coed and Llyn Ogwen, Carnarvonshire!

Scotland.—Corrie Kandor, Aberdeen!

Ireland.—Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Hungary. Galicia. Italy. Norway. Sweden and Bornholm. Poland. Russian Lapland. N. Russia (var.). Greenland. Siberia (var.).

C. tetragonum is a rare species occurring in similar situations to those which yield its nearest ally, *C. notabile* Bréb. It differs from the latter chiefly in its more quadrate and less attenuated semicells, and in its narrower and usually deeper sinus. We have not examined any specimens which correspond exactly with Nägeli's figures, the upper angles of the semicells being invariably more prominent.

Some of the varieties of this species are more general than the typical form.

Var. **Lundellii** Cooke. (Pl. LXVI, figs. 23, 24.)

C. tetragonum forma Lund. Desm. Suec. 1871, p. 42, t. 2, f. 21; Arch. in Quart. Journ. Micr. Sci. 1877, p. 102; Roy & Biss. Scott. Desm. 1894, p. 176.

C. tetragonum var. *Lundellii* Cooke, Brit. Desm. 1887, p. 98, t. 37, f. 18; West, Alg. N. Wales, 1890, p. 289; Heimerl, Desm. alp. 1891, p. 598; West, Alg. Engl. Lake Distr. 1892, p. 724; Lütkem. Desm. Attersees, 1893, p. 550; Johnson, Rare Desm. U.S. II, 1893, p. 294, t. 240, f. 21; West & G. S. West, Alga-fl. Yorks. 1900, p. 81; Freshw. Alg. Orkneys and Shetlands, 1905, p. 21.

? *C. bigorrense* Gay, Alg. Bagn. Bigorr. 1891, p. xxxi (cum fig.).

Semicells with the sides somewhat more convex and

the two lateral undulations more prominent than in the type, especially the upper one which is sometimes very pronounced, with the actual apex considerably narrower, somewhat protracted, and slightly convex: basal angles subrectangular, apical angles scarcely evident (very much rounded).

Length 38–50 μ; breadth 22–29 μ; breadth of isthmus 8–10 μ; thickness 16–19 μ.

England.—Near Keighley, Cockett Moss, near Giggleswick, Cam Fell, and Penyghent, W. Yorks! Mickle Fell, N. Yorks! Pike of Bliscoe and Helvellyn, Westmoreland!

Wales.—Capel Curig and Yr Orsedd, Carnarvonshire!

Scotland.—Aberdeen, Kincardine, Forfar!, Perth!. Argyll (*Roy & Bissett*). Moidart, Inverness! Kirkcudbright! Shetlands!

Geogr. Distribution.—France. Germany. Galicia. Austria. Sweden. Faeroes. Greenland. United States.

This variety is much more generally met with than the typical form, associated with *C. notabile*, *C. speciosum*, *C. anceps*, *C. Holmiense*, and certain other subalpine species, which occur among the Mosses and Myxophyceæ of dripping rocks and mountain springs. It is somewhat variable in the prominence of the lateral undulations of the semicells, especially of the upper one, which sometimes distinctly projects. A form mentioned by Schmidle ('Alg. Geb. Oberrheins,' 1893, p. 549, t. 28, f. 6) possesses a minute tooth on each semicell immediately above the isthmus, but Schmidle's remark "angulis superioribus acutioribus, fere protractis" (in which he really means the superior lateral undulations) applies to the great majority of specimens of this variety. Gutwinski has found Schmidle's form in Galicia and has named it "var. *Lundellii* forma *Schmidlei*" (*vide* Gutw. 'Wykaz. Glonow Wadow.-Makow.' 1897, p. 142).

Var. **heterocrenatum** *var. nov.* (Pl. LXVI, fig. 22.)

Sides of semicells with six *crenations* (including the basal and apical angles), of which the three lower ones are much smaller than the three upper.

Length 34 μ; breadth 23 μ; breadth of isthmus 10·5 μ.

England.—Cowgill Wold Moss, Widdale Fell, W. Yorks!

Var. **Davidsonii** (Roy & Biss.) West & G. S. West. (Pl. LXVI, figs. 25, 26.)

C. Davidsonii Roy & Biss. Scott. Desm. 1894, p. 45, t. 1, f. 8.
C. tetragonum var. *Davidsonii* (Roy & Biss.) West & G. S. West, Alga-fl. Yorks. 1900, p. 81.

Cells rather more hexagonal; sides of semicells straighter, apical angles rounded and more prominent, giving the apex a protracted appearance; isthmus sometimes broader; with minute granules within all the undulations, disposed approximately in radial rows, 2 or 3 in each row.

Length 37–40 μ; breadth 25–26 μ; breadth of isthmus 14–16 μ;

England.—Penyghent, W. Yorks! Mickle Fell, N. Yorks!

Scotland.—Morven and near Aboyne, Aberdeen: near Gillan in Strachan, Kincardine; near Belquhadly in Fern, and in Canlochan, Forfar (*Roy & Bissett*).

Var. **elegans** (Roy & Biss.) *nob.* (Pl. LXVI, fig. 27.)

C. elegans Roy & Biss. Scott. Desm. 1894, p. 45, t. 2, f. 5.

Cells rather more hexagonal; apical angles large, rounded, and very prominent, causing the apex to appear outstanding with a slight subapical constriction; sides of semicells with 3–4 small undulations between the basal and apical angles; within each undulation are two radial rows of about 5 or 6 very minute granules.

Length 43–45 μ; breadth 28–30 μ; breadth of isthmus 17 μ.

Scotland.—Logie-Coldstone and Glassel, Aberdeen (*Roy & Bissett*).

60. **Cosmarium moniliforme** (Turp.) Ralfs. (Pl. LXVII, figs. 1–3.)

? *Tessarthonia moniliforme* Turp. in Dictionnaire des sciences naturelles, 53, 1828, p. 239.

Scenedesmus moniliformis Kütz. Syn. Diat. 1834, p. 607.
Tessararthra moniliformis Ehrenb. in Abh. der Berlin. Akad. 1835, p. 173; Infus. 1838, p. 145, t. 10, f. 20.
Trochiscia moniliformis Menegh. Conspectus algol. Euganeæ, etc., 1837, p. 16; Menegh. Synops. Desm. 1840, p. 239.
Cosmarium moniliforme (Turp.) Ralfs, Brit. Desm. 1848, p. 107, t. 17, f. 6; Arch. in Pritch. Infus. 1861, p. 735; Rabenh. Flor. Europ. Alg. III, 1868, p. 173; Lund. Desm. Suec. 1871, p. 44, t. 3, f. 15; Delp. Desm. subalp. 1877, p. 10, t. 7, f. 42–45 [not f. 40, 41]; Kirchn. Alg. Schles. 1878, p. 147; Wolle, Desm. U.S. 1884, p. 60, t. 15, f. 16–18 [not f. 19]; Cooke, Brit. Desm. 1887, p. 119, t. 43, f. 2; Hansg. Prodr. Algenfl. Böhm. 1888, p. 193; De Toni, Syll. Alg. 1889, p. 932; West, Alg. N. Yorks. 1889, p. 293; Alg. N. Wales, 1890, p. 291; Alg. W. Ireland, 1892, p. 160; Alg. Engl. Lake Distr. 1892, p. 729; Roy & Biss. Scott. Desm. 1894, p. 168; Nordst. Index Desmid. 1896, p. 174; West & G. S. West, Alg. S. England, 1897, p. 491; Alga-fl. Yorks. 1900, p. 86; Alg. N. Ireland, 1902, p. 41; Scott. Freshw. Plankton, I, 1903, p. 526; Further Contrib. Freshw. Plankton Scott. Lochs, 1905, p. 484; Comp. Study Plankton Irish Lakes, 1906, p. 85.
Diplosphærium moniliforme Cramer in Wartm. et Schenk, Schweiz. Krypt. fasc. 3, no. 136.
Dysphinctium moniliforme Reinsch, Algenfl. Franken, 1867, p. 180.
Ursinella moniliformis Kuntze, Revis. gen. plant. 1891, p. 925.

Cells small, about twice as long as broad, deeply constricted, sinus widely open, but usually acute; semicells circular or subcircular. Side view of semicell circular or subcircular. Vertical view circular. Cell-wall smooth. One axile chloroplast in each semicell, with a central pyrenoid and about six radiating vertical plates or lobes (sometimes furcate and more or less irregular).

Zygospore globose and smooth.

Length 21–37·5 μ; breadth 11–20 μ; breadth of isthmus 4–9 μ; diam. zygosp. 37 μ.

England.—Cumberland! Westmoreland! W. N. & E. Yorks! Lancashire! Surrey! Sussex! Devon! Cornwall!

Wales.—Snowdon!, Capel Curig! (*Cooke & Wills*), Moel Siabod!, and Llyn Idwal!, Carnarvonshire. Dolgelly, Merioneth (*Ralfs*).

Scotland.—Sutherland! Ross, Inverness, Aberdeen! Kincardine, Forfar! Perth! Argyll (*Roy & Bissett*). Plankton of Sutherland, Inverness, and Outer Hebrides!

Ireland.—Donegal! Galway! Kerry! Dublin and Wicklow (*Archer*). Plankton of Galway!

Geogr. Distribution.—France. Germany. Galicia.

Hungary. Italy. Norway. Sweden. Denmark. S. Russia. Faeroes. Kordofan. Central China. Japan. India. Burma. Ceylon. Australia. Madagascar. Central Africa. United States. Jamaica. Porto Rico. Brazil. Ecuador. Bolivia.

Roy states that "one form of this species has a distinct isthmus, connecting the semicells; its zygospore (found in a small pool north of Loch Dawin, Aberdeen) is globular, smooth, and twice the size of a semicell." Perhaps this statement refers to *forma panduriformis* Heimerl, a form which we find fairly generally distributed.

Forma **punctata** Lagerh. (Pl. LXVII, fig. 4.)

C. moniliforme β *punctatum* Lagerh. Algol. Bidr. II, 1887, p. 197; West & G. S. West, Alg. Madag. 1895, p. 70, t. 9, f. 31.

Cell-wall punctate, often becoming yellow.

Length 24–43 μ; breadth 14–25 μ; breadth of isthmus 3·5–6·7 μ.

Wales.—Moel Siabod, Carnarvonshire!

Geogr. Distribution.—Madagascar. Porto Rico.

Forma **panduriformis** Heimerl. (Pl. LXVII, figs. 8–9.)

C. moniliforme forma *panduriformis* Heimerl, Desm. alp. 1891, p. 598, t. 5, f. 11; West in Naturalist, 1893, p. 214; Schmidle, Beitr. alp. Alg. 1895, p. 387; West & G. S. West, Alg. S. England, 1897, p. 491; Some Desm. U.S. 1898, p. 310; Alga-fl. Yorks. 1900, p. 86; Alg. N. Ireland, 1902, p. 41; Further Contrib. Plankton Scott. Lochs, 1905, p. 484.

Dysphinctium inferum Turn. Freshw. Alg. E. India, 1893, p. 40, t. 1, f. 21.

? *Pleurotæniopsis Volkensii* Hieron. Conj. in Engl. Pflanzenw. Ost-Africa, 1895, p. 20. [Consult Schmidle, Ost-Afrika Desmid. 1898, p. 25.]

Cells with a broader isthmus and an obtusely rounded sinus; cell-wall smooth.

Length 17·5–25 μ; breadth 10–15 μ; breadth of isthmus 6–10 μ.

England.—Brothers' Water and Helvellyn, Westmoreland! Pilmoor, N. Yorks! Riccall Common, E. Yorks! Thursley Common, Surrey! New Forest, Hants! Withiel, Cornwall!

Wales.—Capel Curig, Carnarvonshire! Not uncommon in the plankton of the Carnarvonshire lakes!

Scotland.—Rhiconich, Sutherland! Moidart, and

plankton of Loch Bairness, Inverness! Skye! Plankton of Loch Fadaghoda, Lewis, Outer Hebrides!

IRELAND.—Near Glenties, Donegal! Foxford and Achill Is., Mayo! Jar Connaught, and near Roundstone, Galway! Carrantuohill, Kerry!

Geogr. Distribution.—Austria. Australia.

We find this form much more abundantly than the type, and in the smaller upland bog-pools it not infrequently occurs in large quantity. It is one of the smallest forms of the species and is well characterized by its broader isthmus and rounded sinus. A punctate form of it is known from the plankton of Loch Bairness, Inverness (*vide* West & G. S. West, 'Further Contrib. Plankton Scott. Lochs,' 1905, p. 499, t. 7, f. 6); length 21–22 μ, breadth 11·5–13 μ; breadth of isthmus 7·5 μ (Pl. LXVII, fig. 10).

Forma **elongata** West & G. S. West. (Pl. LXXV, fig. 10.)

C. moniliforme forma *elongata* West & G. S. West, Some Desm. U.S. 1898, p. 311 ["lat. 11 μ" is a misprint for lat. 17 μ], t. 17, f. 14.

Cells elongated; semicells broadly elliptical with the long axis longitudinal; vertical view circular.

Length 38–42 μ; breadth 17–20 μ; breadth of isthmus 4–7 μ.

IRELAND.—Ballynahinch, Galway!

Geogr. Distribution.—United States.

Var. **subpyriforme** *var. nov.* (Pl. LXVII, fig. 5.)

Semicells somewhat angularly obovate, lateral margins in the lower part slightly flattened, and with the apex also very slightly flattened.

Length 40 μ; breadth 20 μ; breadth of isthmus 7·7 μ.

ENGLAND.—New Forest, Hants!

Var. **limneticum** *var. nov.* (Pl. LXVII, figs. 6, 7.)

C. moniliforme forma *panduriformis* Heimerl forma *b* West & G. S. West, Further Contrib. Freshw. Plankton Scott. Lochs, 1905, p. 500, t. 7, f. 4, 5.

Cells often rather large, semicells very faintly produced at the apices which are slightly angular; isthmus

much broader than in the type; sinus obtuse, often rounded.

Length 37–52 μ; breadth 19–27 μ; breadth of isthmus 12–14·8 μ.

Scotland.—In the plankton of Loch Fadaghoda, Lewis, Outer Hebrides!

Ireland.—In the plankton of several small lakes between Clifden and Roundstone, and also in the plankton of Lough Corrib, Galway!

Geogr. Distribution.—Australia (in plankton).

This variety appears to be mostly a plankton-form. It is readily distinguished by the slight angularity of the apices and the wide isthmus. The widest part of the semicell is nearer the base than the apex, and the upper half is commonly rounded-conical in form.

61. **Cosmarium alpestre** Roy & Biss.

(Pl. LXVII, fig. 14.)

Cosmarium alpestre Roy & Biss. Scott. Desm. 1894, p. 41, t. 1, f. 6.

Cells large, a little longer than broad, very slightly and broadly constricted; semicells subsemicircular, sometimes faintly flattened at the apex. Side view of semicell subsemicircular. Vertical view very broadly elliptic, ratio of axes 1 : 1·15. Cell-wall densely and finely punctate, with a row of rather larger punctæ bordering the broad isthmus on each side.

Zygospore unknown.

Length 90–105 μ; breadth 75–90 μ; breadth of isthmus 79 μ; thickness 60 μ.

Scotland.—Press Whin on the north side of Morven, Aberdeen; North-west side of Glas Mhoel, above the Cairnwell, Perth (*Roy & Bissett*).

We have not seen this species which Messrs. Roy & Bissett state to be very rare and not hitherto found under 2,000 ft. Its relative breadth and the slightness of its constriction at once distinguish it from *C. connatum* Bréb. In outward form it most nearly resembles the Desmid described by Delponte as *Dysphinctium ellipticum* (*vide* Delp. 'Desm. subalp.,' 1877, p. 134, t. 21, f. 14).

62. **Cosmarium connatum** Bréb.

(Plate LXVII, figs. 15–17.)

Cosmarium connatum Bréb. in Ralfs' Brit. Desm. 1848, p. 108, t. 17, f. 10; De Bary, Conj. 1858, p. 41, 72, t. 6, f. 47; Arch. in Pritch. Infus. 1861, p. 735; Rabenh. Flor. Europ. Alg. III, 1868, p. 175; Delp. Desm. subalp. 1877, p. 31, t. 9, f. 23–25; West, Alg. W. Ireland, 1892, p. 161; Alg. Engl. Lake Distr. 1892, p. 729; Lütkem. Desm. Attersees, 1893, p. 549; Roy & Biss. Scott. Desm. 1894, p. 44; Nordst. Index Desm. 1896, p. 79; West & G. S. West, Alg. S. England, 1897, p. 492; Alg.-fl. Yorks. 1900, p. 87; Alg. N. Ireland, 1902, p. 41; Further Contrib. Freshw. Plankton Scott. Lochs, 1905, p. 483.

Dysphinctium Meneghinianum Näg. Gatt. einz. Alg. 1849, p. 112, t. 6 G, f. 2.

Dysphinctium connatum Reinsch, Algenfl. Franken, 1867, p. 178; Hansg. Prodr. Algenfl. Böhm. 1888, p. 185; De Toni, Syll. Alg. 1889, p. 884; Heimerl, Desm. alp. 1891, p. 594; Schmidle, Lappmark Süsswasseralgen, 1898, p. 20.

Calocylindrus connatus Kirchn. Alg. Schles. 1878, p. 143; Wolle, Desm. U.S. 1884, p. 55, t. 12, f. 9 [not fig. 8]; Cooke, Brit. Desm. 1887, p. 124, t. 44, f. 2; Benn. Freshw. Alg. S. W. Surrey, 1892, p. 11, t. 2, f. 15.

Calocylindrus connatus a. *typicum* Klebs, Desm. Ostpreuss. 1879, p. 29.

Cells large, almost $1\frac{1}{3}$ times longer than broad, moderately constricted, sinus very widely open with an obtuse apex; semicells transversely subelliptic with a broad base, apex commonly very slightly flattened. Vertical view subcircular, slightly compressed. Cell-wall often somewhat thick, finely scrobiculate, and densely but minutely punctate between the scrobiculations. Chloroplasts disposed in relation to two large pyrenoids in each semicell, with numerous, somewhat irregular, and often furcate lobes extending outwards until they become flattened against the inner surface of the cell-wall.

Zygospore unknown.

Length 65–100 μ; breadth 46–74 μ; breadth of isthmus 40–50 μ; thickness 45–56 μ.

England.—Borrowdale and Bassenthwaite Water, Cumberland! Ambleside (*Ralfs*), Bowness! (*Bissett*), Westmoreland. Hawkshead and near Cockley Beck, Lancs.! Cullingworth and Ilkley, W. Yorks! Puttenham and Thursley Commons, Surrey! Enbridge Lake (*Roy*) and New Forest!, Hants.

Wales.—Capel Curig, Carnarvonshire! (*Cooke & Wills*). Dolgelly, Merioneth (*Ralfs*).

Scotland.—Sutherland!, Ross, Inverness!, Aberdeen, Kincardine, Perth!, Argyll, Stirling (*Roy & Bissett*). Harris, Outer Hebrides! In the plankton of Lochs nan Cuinne and Ruar, Sutherland!; also plankton of Loch Fadaghoda, Lewis!

Ireland.—Near Glenties and Lough Anna, Donegal! Ballynahinch, Lakes near Recess, Clifden to Roundstone, Loughs Aunierin and Derryclare, and Loughs east of Lough Bofin, Galway! Dublin and Wicklow (*Archer*). Slieve Donard, Down! In plankton of small lakes, Clifden to Roundstone, Galway!

Geogr. Distribution.—France. Germany. Austria. Hungary. Galicia. Italy. Norway. Sweden. Denmark. Bornholm. Finland. S. Russia. Japan. India. Burma. Singapore. Sumatra (form). Java. Central Africa. Sandwich Isles. United States. Guiana. Brazil.

C. connatum is generally distributed in Scotland, Ireland, and the western areas of England and Wales, but is decidedly local. It is rarely found among *Sphagnum*, having a preference for the margins of lakes where it often occurs among other Desmids around such plants as *Isoëtes*, *Utricularia*, *Eriocaulon*, etc.

Var **truncatum** West. (Pl. LXVII, fig. 18.)

C. connatum var. *truncatum* West, Alg. W. Ireland, 1892, p. 161, t. 21, f. 16.

Cells more deeply constricted, with broadly truncate apices.

Length 105μ; breadth 75μ; breadth of isthmus 45μ.

England.—Hawkshead, Lancashire!

Ireland.—Derryclare Lough, Galway!

This variety is well-marked by its increased depth of constriction and by its broadly flattened apices. We have only observed it once since its first discovery in Ireland.

63. **Cosmarium pseudoconnatum** Nordst. (Pl. LXVII, fig. 19–21.)

Cosmarium pseudoconnatum Nordst. Desm. Brasil. 1870, p. 214, t. 3, f. 17; Lund. Desm. Suec. 1871, p. 45; West, Alg. W. Ireland, 1892, p. 161; Alg. Engl. Lake Distr. 1892, p. 729; Roy & Biss. Scott. Desm. 1894,

p. 172; Nordst. Index Desm. 1896, p. 208; West & G. S. West, Alg. S. England, 1897, p. 492; Freshw. Chlorophy. Koh Chang, 1901, p. 176; Alga-fl. Yorks. 1900, p. 87; Alg. N. Ireland, 1902, p. 41.

C. connatum b. *pseudoconnatum* Klebs, Desm. Ostpreuss. 1879, p. 29.

Calocylindrus pseudoconnatus (Nordst.) Wolle in Bull. Torr. Bot. Club, viii, 1881, p. 39; Cooke, Brit. Desm. 1887, p. 124, t. 44, f. 3; West, Alg. N. Yorks. 1889, p. 293; Alg. N. Wales, 1890, p. 291.

Pleurotæniopsis pseudoconnatus (Nordst.) Lagerh. Algol. Bidr. II, 1887, p. 197; De Toni, Syll. Alg. 1889, p. 908.

Cosmaridium pseudoconnatum Hansg. Prodr. Algenfl. Böhm. 1888, p. 245.

Dysphinctium pseudoconnatum (Nordst.) Turn. Freshw. Alg. E. India, 1893, p. 43.

Cells of moderate size, almost $1\frac{1}{2}$ times as long as broad, very slightly constricted by a broad and very shallow sinus; semicells semi-elliptic with a slightly narrowed base, in outline about two-thirds the circumference of a circle. Vertical view circular or subcircular. Cell-wall punctate, the punctulations near the isthmus being sometimes arranged in transverse series. Chloroplasts parietal, 4 in each semi-cell, each with one pyrenoid.

Zygospore unknown.

Length 47·5–57·5 μ; breadth 33–44 μ; breadth of isthmus 31–40 μ.

England.—Loughrigg, and near Bowness, Westmoreland! (*Bissett*). Mickle Fell, N. Yorks! New Forest, Hants!

Wales.—Near Bethesda!, and Capel Curig, Carnarvonshire! (*Cooke & Wills*).

Scotland.—Rhiconich, Sutherland! Tomachar and Dawin in Cromar, Dalbagie near Ballater, Aberdeen (*Roy & Bissett*). Skye in Inverness! Lewis and Harris, Outer Hebrides! New Galloway, Kirkcudbright!

Ireland.—Lough Anna, Donegal! Roundstone, Ballynahinch, Athry Lough, and loughs east of Lough Bofin, Galway! Muckross, Upper Lake of Killarney, and Adrigole, Kerry!

Geogr. Distribution.—France. Austria. Norway. Sweden. India. Ceylon (var.). Siam. Java (var.). Madagascar. United States. West Indies. Brazil. Ecuador. Paraguay.

C. pseudoconnatum is a smaller species than *C. connatum*, with a slighter constriction and more rounded semicells. The chloroplasts are also of a very different character from those of *C. connatum*. It is a rare Desmid, and is principally confined to small pools in the western areas of old rocks.

Wille has described ('Sydamerik. Algfl.' 1884, p. 18) a 'forma *major*' from Brazil (length 76 μ; breadth 50 μ), and Lütkemüller has given measurements of Austrian forms of about the same size (length 66–73 μ; breadth 49–52 μ; breadth of isthmus 42–44 μ). Turner has mentioned a small form from India with a length of only 41 μ and a breadth of 26·5 μ.

Var. **ellipsoideum** West & G. S. West. (Pl. LXVII, fig. 22.)

? *Calocylindrus connatus* var. *minor* Wolle, Desm. U.S. 1884, t. 12, f. 55.
Cosmarium pseudoconnatum var. *ellipsoideum* West & G. S. West, Freshw. Alg. Ceylon, 1902, p. 168, t. 20, f. 43–45; Gutw. Alg. Ins. Java, 1902, p. 588 [under *Pleurotæniopsis*].

Cells slightly larger than usual, constriction somewhat deeper, apices of semicells often slightly flattened; vertical view broadly elliptic.

Length 56–63·5 μ; breadth 38·5–45 μ; breadth of isthmus 32·5–38·5 μ; thickness 36 μ.

Geogr. Distribution.—Burma. Ceylon. Singapore. Java.

This variety is as yet only known to occur in the Indo-Malayan region, where it is met with much more frequently than the typical form. The combination of a deeper constriction with a broadly elliptic vertical view is very characteristic.

It agrees fairly well with the figure of "*Calocylindrus connatus* var. *minor* Wolle," which is most probably a form of *Cosmarium pseudoconnatum*, but Wolle's published description and figure are insufficient to settle this point. We have previously pointed out how very confused Wolle seems to have been in his ideas of *C. connatum* and *C. pseudoconnatum*.

We introduce this variety here because we have observed some forms from Harris, Outer Hebrides, which appear to be intermediate between it and the type. In front view they possess a deeper constriction which gives them an outline almost exactly corresponding to that of var. *ellipsoideum*, but the vertical view is circular. Length 57–60 μ; breadth 39–42 μ; breadth of isthmus 33–36 μ.

Var. **constrictum** West. (Pl. LXVII, fig. 23.)

C. pseudoconnatum var. *constrictum* West, Alg. W. Ireland, 1892, p. 161, t. 21, f. 17.

Slightly larger than the average size of this species and much more deeply constricted, causing the semicells to be transversely broadly elliptic.

Length 65 μ; breadth 43 μ; breadth of isthmus 26 μ.

Ireland.—Ballynahinch, Galway!

64. **Cosmarium globosum** Bulnh.

(Pl. LXVIII, figs. 1, 2.)

Cosmarium globosum Bulnh. in Hedwigia, 1861, p. 52, t. 9, f. 8; Rabenh. Flor. Europ. Algar. III, 1868, p. 178; Lund. Desm. Suec. 1871, p. 45; Cooke, Brit. Desm. 1887, p. 121, t. 43, f. 6 [figures incorrect]; West, Alg. N. Wales, 1890, p. 291; West, Alg. W. Ireland, 1892, p. 160; Alg. Engl. Lake Distr. 1892, p. 729; Roy & Biss. Scott. Desm. 1894, p. 102; Nordst. Index Desmid. 1896, p. 130; West & G. S. West, Alg. S. England, 1897, p. 491; Alga-fl. Yorks. 1900, p. 87; Freshw. Alg. Orkneys and Shetlands, 1905, p. 22.

Calocylindrus strangulatus Cooke & Wills in Cooke, Brit. Desm. 1887, p. 128, t. 44, f. 10; West, Alg. N. Yorks. 1889, p. 293.

Dysphinctium globosum Hansg. Prodr. Algenfl. Böhm. 1888, p. 243; De Toni, Syll. Alg. 1889, p. 880; Heimerl, Desm. alp. 1891, p. 593.

Dysphinctium strangulatum De Toni, Syll. Alg. 1889, p. 887.

Cosmarium globosum Bulnh. forma Borge, Süssw. Chlor. Archang. 1894, p. 23, t. 2, f. 20.

Cells small, about $1\frac{3}{4}$ times as long as broad, slightly constricted, sinus rapidly widening from an acute apex; semicells subcircular (outline about two-thirds the circumference of a circle); vertical view circular, rarely very slightly compressed. Cell-wall punctate, punctulations sometimes very obscure, but frequently very distinct. Chloroplasts axile, one in each semicell, with a central pyrenoid from which radiate a number (7–9) of vertically-disposed lobes (sometimes rather irregular).

Zygospore unknown.

Length 30–36 μ; breadth 22–25 μ; breadth of isthmus 17–19 μ.

England.—Angle Tarn and near Cockermouth, Cumberland! Near Stickle Tarn, Westmoreland!

Filey, E. Yorks. (subfossil in peat deposit)! Mickle Fell, N. Yorks! Hants! Devon! (*Bennett*).

Wales.—Capel Curig! (*Cooke & Wills*), and Snowdon!, Carnarvonshire! Llyn Coron, Anglesey! In the plankton of Llyn Ogwen!

Scotland.—Inverness, Aberdeen, Kincardine (*Roy & Bissett*). Shetlands!

Ireland.—Lakes East of Lough Bofin, Galway! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Norway. Sweden. Denmark. Finland. N. Russia. Nova Zembla. Spitzbergen. Greenland. Central China (form). Ceylon (var.). Australia (var.). E. Africa. United States. Guiana. Brazil. Argentina. Patagonia.

The zygospore of typical *C. globosum* has not yet been observed, but that of one of its varieties—var. *Wollei* West & G. S. West—is known from the United States (*vide* West & G. S. West, 'Some N. Amer. Desm.' 1896, p. 252, t. 15, f. 17). This zygospore is angular-globose or irregularly spherical, with a smooth wall, and a diameter from 28 to 34 μ.

C. globosum is distinguished from *C. moniliforme* by its relatively broader cells and much broader isthmus. It is also a much rarer species than *C. moniliforme*.

Forma **minor** Boldt.

C. globosum forma *minor* Boldt, Desmid. Grönland, 1888, p. 16; West & G. S. West, Alg. N. Ireland, 1902, p. 41.

Smaller than the typical plant, but otherwise similar and with a circular vertical view.

Length 16·8–24 μ; breadth 12–15 μ; breadth of isthmus 10·8–12 μ.

Ireland.—Slievecommedagh, Down!

Geogr. Distribution.—Greenland.

Var. **minus** Hansg. (Pl. LXVIII, figs. 3–5.)

Cosmarium globosum Bulnh. forma Nordst. Desm. Arctoæ, 1875, p. 28, t. 7, f. 25 [according to Hansgirg].

C. moniliforme var. *α* Delp. Desm. subalp. 1877, p. 10, t. 7, f. 40, 41 [according to Hansgirg].

Dysphinctium globosum var. *minus* Hansg. Prodr. Algenfl. Böhm. 1888, p. 243; West & G. S. West, Alg. S. England, 1897, p. 491.

A small variety with depressed semicells; apices distinctly flattened but at the same time slightly convex; vertical view elliptic; cell-wall smooth.

Length 17–22 μ; breadth 13–18 μ; breadth of isthmus 9·5–15 μ; thickness 9–16 μ.

England.—Epping Forest, Essex! Near Senens, Cornwall!

Geogr. Distribution.—Bohemia. Italy. Spitzbergen. E. Africa.

Hansgirg includes both Norstedt's forms (1875) and Delponte's "*C. moniliforme* var. *a*" in his var. *minus*, and in this we have followed him. It would be impossible to separate these various forms as they agree so closely in the shape of the sinus, although Delponte's Italian plants, of which we give a figure (Pl. LXVIII, fig. 5), are not so depressed at the apex as the others.

It is a small variety with depressed apices similar to those of *C. pseudarctoum*, but with a different kind of constriction and an elliptic vertical view.

65. **Cosmarium subarctoum** (Lagerh.) Racib.

(Pl. LXVIII, figs. 6–8.)

Cosmarium globosum Bulnh. subsp. *subarctoum* Lagerh. in Wittr. & Nordst. Alg. Exsic. 1883, no. 567; fasc. 21, 1889, p. 45; Nordst. Desm. Grönl. 1885, p. 9, t. 7, f. 5;

C. subarctoum (Lagerh.) Racib. Desmidyja Ciastonia, 1892, p. 385, t. 6, f. 24; West & G. S. West, Alg. S. England, 1897, p. 491; Comp. Study Plankton Irish Lakes, 1906, p. 100.

Cells very small, about $1\frac{1}{4}$ times as long as broad, moderately constricted, sinus open and subrectangular with a subacute apex; semicells transversely subelliptic, apex convex but somewhat flattened, sides rounded. Side view of semicell broadly elliptic or subglobose. Vertical view elliptic, ratio of axes about 1 : 1·3 to 1·4. Cell-wall smooth, sometimes becoming yellow. Chloroplasts axile, one in each semicell, with one central pyrenoid.

Zygospore unknown.

Length 15–21·5 μ; breadth 12–17 μ; breadth of isthmus 8·5–11·5 μ; thickness 8·5–11 μ.

England.—Esher West-end Common, Surrey!

Scotland.—In the plankton of Loch Fadaghoda, Lewis, and Loch Laxadale, Harris, Outer Hebrides!

Ireland.—Plankton of Loughs Caragh, Currane, and Guitane, Kerry!

Geogr. Distribution.—Sweden. N. Russia. Greenland. Australia (form). Argentina.

This minute species, which sometimes occurs in quantity in the plankton, is a very near relative of several others, from which it is necessary to distinguish it. From *C. arctoum* Nordst. it is distinguished by its deeper constriction and the narrower apices of the semicells; from *C. bioculatum* Bréb. by its shallower constriction and slightly flattened apices; from *C. tinctum* Ralfs by its proportionately broader cells, its more depressed semicells, its more delicate and colourless cell-wall. In the breadth of its isthmus it resembles *C. asphærosporum* Nordst. (consult vol. ii, p. 163, pl. lx, figs. 24, 25), but differs from that species in the more convex apices and in the elliptical vertical view.

Another closely allied species, which would perhaps be better considered as a form of it, is *C. affine* Racib. ('Desmidyja Ciastonia,' 1892, p. 363, t. 6, f. 25).

Nordstedt has recorded a very minute form from Sweden: length 12 μ; breadth 10 μ; breadth of isthmus 7 μ; thickness 6 μ (*vide C. globosum* Bulnh. **subarctoum* Lagerh. f. *minor* Nordst, in Wittr. & Nordst. 'Alg. Exsic.' 1889, no. 966; fasc. 21, 1889, p. 45).

Forma **punctata** West & G. S. West. (Pl. LXVIII, fig. 9.)

C. subarctoum forma *punctata* West & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 22, t. 2, f. 24.

Cell-wall distinctly and irregularly punctate.

Length 16–19 μ; breadth 13·5–16 μ; breadth of isthmus 8·6–10·5 μ; thickness 9–10 μ.

Scotland.—Plankton of Loch Beosetter, Bressay, Shetlands!

66. **Cosmarium pseudarctoum** Nordst.

(Pl. LXVIII, figs. 12–14; Pl. LXXII, figs. 40, 41.)

Cosmarium pseudarctoum Nordst. in Wittr. & Nordst. Alg. Exsic. 1879, no. 257, cum fig. xylogr.; in fasc. 21, 1889, p. 45; Boldt, Desmid. Grönland, 1888, p. 17; West, Alg. W. Ireland, 1892, p. 162; Alg. Engl.

Lake Distr. 1892, p. 729, t. 9, f. 16; Nordst. Index Desmid. 1896, p. 207; West & G. S. West, Alg. S. England, 1897, p. 491; Alga-fl. Yorks. 1900, p. 87; Alg. N. Ireland, 1902, p. 41; Freshw. Alg. Orkneys & Shetlands, 1905, p. 22.

Calocylindrus pseudarctous Cooke, Brit. Desm. 1887, p. 129, t. 44, f. 6; West, Add. Alg. W. Yorks, 1889, p. 92.

Dysphinctium pseudarctoum De Toni, Syll. Alg. 1889, p. 879.

Cells very small, about $1\frac{1}{4}$ times as long as broad, very slightly constricted, sinus a very shallow depression; semicells widely subovate, apex often subtruncate. Side view of semicell semi-elliptic with a slightly narrowed base. Vertical view subcircular or circular-elliptic. Cell-wall smooth. Chloroplasts axile, one in each semicell, with a central pyrenoid and four radiating cruciately-disposed lobes (often very irregular and most obscure).

Zygospore subglobose or angular-globose, smooth.

Length 16·3–24 μ; breadth 11·2–18 μ; breadth of isthmus 10–16·8 μ; thickness 10·5–14·5 μ; diam. zygosp. 14·4–18 μ.

England.—Wastdale, Cumberland! Pike of Bliscoe, Loughrigg, and Helvellyn, Westmoreland! Hawkshead, Lancs.! Ogden Clough, Rombald's Moor, and Cautley Spout, W. Yorks! Carlton Bank, N. Yorks! Esher West-end Common, Surrey!

Wales.—Capel Curig, Llyn Idwal, Llyn Ogwen, Llyn-y-cwm-ffynon, and Llyn Geirionedd, Carnarvonshire!

Scotland.—Clova Mts., Forfar! Skye in Inverness! Orkneys! Shetlands!

Ireland.—Errigal, Donegal! Ballynahinch, Galway! Carrantuohill and near Lough Brin, Kerry! Slieve Donard, Down! Lough Fea, Londonderry!

Geogr. Distribution.—Norway. Greenland. Switzerland. Siam.

We sometimes meet with this minute species in abundance in upland and subalpine localities, often amongst mosses on wet rocks, and more rarely amongst submerged *Sphagnum* and *Hypnum* in peaty areas. The zygospores we have only seen from wet rocks on the Gornergrat at 8500 ft.

C. pseudarctoum differs from *C. arctoum* in the upward

narrowing of the semicells which gives the cell a very different outward form. It stands nearest in its general appearance to *Penium cruciferum* (De Bary) Wittr., but differs in its proportionately shorter cells, its slightly compressed vertical view, and its more irregular chloroplast.

A considerable irregularity is shown by the semicells of this Desmid, the two semicells of one individual being often of different form. The sinus varies much in shape, and the apex of the semicell may or may not be subtruncate.

A rather narrower form of this species, with cells almost twice as long as broad, occurs in the plankton of Loch Asta, Shetlands. Length 17 μ; breadth 9·2 μ. (Pl. LXVIII, fig. 15.)

67. **Cosmarium pericymatium** Nordst. (Pl. LXVIII, fig. 10.)

Cosmarium pericymatium Nordst. Desm. Arctoæ, 1875, p. 29, t. 7, f. 26; De Toni, Syll. Alg. 1889, p. 1038; Johnson, Rare Desm. U.S. II, 1895, p. 293, t. 240, f. 28.
Ursinella pericymatia Kuntze, Revis. gen. plant. 1891, p. 925.
Dysphinctium pericymatium Schmidle, Beitr. alp. Alg. 1895, p. 348.

Cells of moderate size, about $1\frac{1}{3}$ times longer than broad, moderately constricted, sinus open and obtuse; semicells semi-elliptic with a slightly contracted base, margin gently undulate with about 16 small undulations. Side view of semicell semi-oblong-elliptic with a very slightly contracted base. Vertical view very broadly elliptic, slightly produced at the poles. Cell-wall somewhat thick and densely punctate.

Zygospore unknown.

Length 40–51 μ; breadth 28–32 μ; breadth of isthmus 23–25 μ; thickness 24–27 μ.

Geogr. Distribution.—Germany. Sweden. Spitzbergen. United States.

The typical plant is not known to occur in the British Islands.

Var. **eboracense** West & G. S. West. (Pl. LXVIII, fig. 11.)

C. pericymatium var. *eboracense* West & G. S. West, Notes Alg. II, 1900, p. 292, t. 412, f. 4; Alga-fl. Yorks. 1900, p. 88.

A smaller variety; semicells with fewer and more prominent undulations.

Length 21 μ; breadth 14 μ; breadth of isthmus 10 μ; thickness 12 μ.

England.—Cautley Spout, W. Yorks!

This variety occurred among mosses on wet rocks. It is very probable that the typical form will be found in the more northern ghylls and glens of the British Islands as there are numerous suitable habitats which have not yet been investigated.

68. **Cosmarium Novæ-Semliæ** Wille.
(Pl. LXVIII, fig. 16.)

Cosmarium Novæ-Semliæ Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 46, t. 13, f. 45; Lemaire, Liste Desm. Vosges, 1883, p. 21, t. 1, f. 4; De Toni, Syll. Alg. 1889, p. 1012; Nordst. Index Desmid. 1896, p. 184.
Ursinella Novæ-Semliæ Kuntze, Revis. gen. plant. 1891, p. 925.

Cells very small, about $1\frac{1}{4}$ times as long as broad, slightly constricted, sinus widely excavated and shallow, isthmus somewhat elongated; semicells transversely oblong, apex retuse, sides truncately rounded and furnished with four denticulations, with two oblique series of denticulations (2 in the outer series and 3 in the inner series) within each side, and with a small but conspicuous central wart. Side view of semicell ovate-elliptic with a papilla at the middle of each side. Vertical view broadly elliptic, ratio of axes about 1 : 1·5, with about 5 denticulations round the margin of each pole, and a prominent papilla at the middle on each side. Chloroplast axile with a central pyrenoid.

Zygospore unknown.

Length 15–20 μ; breadth 12–16 μ; breadth of isthmus 6–8 μ; thickness 11–12 μ.

England.—Cocket Moss, near Giggleswick, and in bog two miles south of Clapham, W. Yorks!

Geogr. Distribution. — France. Galicia. Nova Zembla. Faeroes. East Africa.

C. Novæ-Semliæ is a very much rarer species than *C. Regnesi*, from which it is distinguished by its proportionately greater length, the more rounded sides of the semicells, the arrangement of the denticulations, and by the small peg-like papilla in the centre of each semicell.

Var. **sibiricum** Boldt. (Pl. LXVIII, figs. 17, 18.)

C. Novæ-Semliæ var. *sibiricum* Boldt, Siber. Chlorophy. 1885, p. 108, t. 5, f. 14; West & G. S. West, Alg. S. England, 1897, p. 487.

A distinct variety with a deeper sinus and narrower isthmus; apex of semicells retuse-emarginate; denticulations round the lateral margins prominent, and only very few (2 or 3) within each margin; vertical view more narrowly elliptic.

Length 17–18 μ; breadth 15–15·5 μ; breadth of isthmus 6·5–7 μ; thickness 9·5–10 μ.

England.—New Forest, Hants! (very abundant in Ashurst Bog, June, 1897).

Geogr. Distribution.—Siberia.

69. **Cosmarium Regnesi** Reinsch.

(Pl. LXVIII, figs. 19–28.)

Cosmarium Regnesi Reinsch, Spec. Gen. Alg. 1867, p. 116, t. 22 A III, f. 1–5; Contrib. Alg. et Fung. 1875, p. 89, t. 10, f. 12; Turn. Notes Freshw. Alg. 1886, p. 34, t. 1, f. 10; Cooke, Brit. Desm. 1886, p. 95, t. 42, f. 19; De Toni, Syll. Alg. 1889, p. 961; West, Alg. N. Wales, 1890, p. 289; Alg. W. Ireland, 1892, p. 149; Alg. Engl. Lake Distr. 1892, p. 726; Roy & Biss. Scott. Desm. 1894, p. 173; West & G. S. West, Alg. Madag. 1895, p. 59, t. 6, f. 44; New and Int. Freshw. Alg. 1896, p. 155, t. 3, f. 30, 31; Nordst. Index Desm. 1896, p. 222; West & G. S. West, Alg. S. England, 1897, p. 487; G. S. West, Variation Desm. 1899, p. 387, t. 10, f. 10, 12–17; West & G. S. West, Alga-fl. Yorks. 1900, p. 89; Alg. N. Ireland, 1902, p. 36 [inclus. var. *montanum*]; Freshw. Alg. Orkneys and Shetlands, 1905, p. 22.

Didymidium (*Cosmarium*) *Regnesi* Reinsch, Algenfl. Franken, 1867, p. 112, t. 7, f. 8.

Ursinella Regnesi Kuntze, Revis. gen. plant. 1891, p. 925.

Cells very small, about as long as broad, deeply constricted, sinus open, rounded, and widely excavated; semicells transversely oblong-rectangular with six (rarely with eight) minute marginal teeth, which are generally more or less equidistant, two apical and two lateral, apex (between the apical teeth) widely retuse. Side view of semicell subcircular-elliptic. Vertical view elliptic, ratio of axes about 1 : 2. Cell-wall smooth. Chloroplasts axile, with one central pyrenoid.

Zygospore generally rhomboid, with the sides slightly concave and the angles rounded; sometimes rounded-

quadrate or pentagonal; spore-wall smooth and becoming yellow-brown.

Length 6–10 μ; breadth 6·2–9·5 μ; breadth of isthmus 3–4·7 μ; thickness 4–5·2 μ; length of zygosp. 15–19 μ; breadth 11·5–13 μ.

England.—Brothers' Water, Helvellyn, and Esthwaite Water, Westmoreland! Riccall Common, E. Yorks! Thursley Common, Surrey (with zygospores)! New Forest, Hants! Crowan, Cornwall!

Wales.—Capel Curig!, Llyn Idwal!, and Yr Orsedd!, Carnarvonshire.

Scotland.—Sutherland!, Ross, Inverness!, Banff, Aberdeen, Kincardine, Forfar!, Perth!, Stirling, Argyll! (*Roy & Bissett*). Outer Hebrides! Shetlands!

Ireland.—Donegal! Mayo! Galway! Kerry! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Sweden. Bornholm. Faeroes. Japan. Ceylon (var.). Australia. New Zealand (var.). Madagascar. United States. West Indies. Brazil. Australia.

C. Regnesi is not an uncommon species in the boggy margins of pools and lakes, both in lowland and upland areas, but owing to its minute size it is easily overlooked. We find the normal type of semicell to be a six-toothed one, with the margin concave between each pair of teeth and widely retuse in the middle of the apex. The commonest departures from this type are the eight-toothed forms, in which the two lateral teeth are replaced by three equidistant ones, or the upper lateral tooth is replaced by two situated close together. In the latter form the semicells appear to possess emarginate upper angles. Occasionally the inferior angles are slightly emarginate, and this causes a conspicuous alteration in the form of the sinus. The vertical view is typically elliptic, but sometimes there is a slight indication of a central protuberance.

Sometimes immense quantities of *C. Regnesi* may be obtained from among the leaves of the submerged species of *Sphagnum* and *Utricularia minor*. Such multitudes have resulted from active cell-division under favourable circumstances, and irregularities are by no means infrequent. It often happens that a second division commences before the new semicells resulting from the first division have attained their normal size and characteristics. This may be continued until several

immature cells intervene between the original adult semicells (Pl. LXVIII, fig. 25). These immature cells are often set free and commence division while still in a juvenile and undeveloped condition. The new semicells resulting from this division are as often as not quite typical, showing all the characters of the species (Pl. LXVIII, fig. 24). Thus, if the distinctive features of a species are partially lost through repeated rapid divisions, they may make their appearance in a most pronounced manner in the semi-cells of a succeeding generation.

The most marked variety of this species—var. *productum* West and G. S. West ('Freshw. Alg. Ceylon,' 1902, p. 166, t. 20, f. 35)—is known from Ceylon and Java. The superior angles of the semicells are produced outwards to such an extent as to appear almost like short processes.

In 1903, Schmidt ('Grundl. Algenfl. Lüneburg. Heide,' p. 21) placed this Desmid under the genus *Sphærozosma*, but the plant which he had in such abundance in the filamentous condition is without doubt a form of *Sphærozosma Wallichii* Jacobsen. We have examined *Cosmarium Regnesi* from almost every part of the world, and have described all its known varieties. We have examined specimens from hundreds of different collections, in some of which it occurred very sparingly, in others in prodigious abundance, and we have never yet seen what could be truly described as a filamentous form of this species. The nearest approach to such a state is the short chain of immature individuals resulting from very rapid division, which we have figured on Pl. LXVIII, fig. 25. Moreover, Schmidt has placed as synonyms of *C. Regnesi* Desmids with which that species has not the slightest affinity, his entire statements (l.c. pp. 21–23) appearing to us to indicate a most superficial and imperfect knowledge of the plants in question.

Hansgirg has described a trigonal variety (var. *trigonum*) of *C. Regnesi* from Bohemia.

Var. **tritum** West. (Pl. LXVIII, figs. 35, 36.)

C. Regnesi var. *tritum* West, Alg. W. Ireland, 1892, p. 149, t. 21, f. 3; West & G. S. West, Alg. Madag. 1895, p. 59, t. 9, f. 24.

Semicells with the angles bluntly rounded and not toothed.

Length 6·6–8·5 μ; breadth 6·6–8·5 μ; breadth of isthmus 3·7–5 μ; thickness 3·9–4 μ.

England.—Pilmoor, near Thirsk, N. Yorks!
Ireland.—Creggan Lough and Kylemore, Galway!
Geogr. Distribution.—Madagascar.

Var. **montanum** Schmidle. (Pl. LXVIII, figs. 29–31.)

C. Novæ-Semliæ Wille var. *polonicum* Eichler & Gutw. Nonn. spec. alg. nov. 1894, p. 170, t. 5, f. 27.
C. Regnesi var. *montanum* Schmidle, Weit. Beitr. Algenfl. Rheineb. u. Schwarzwald. 1895 (April), p. 74, t. 1, f. 9 (figure bad); Beitr. alp. Alg. 1895, p. 389, t. 15, f. 11; West & G. S. West, Alga-fl. Yorks. 1900, p. 89.
C. Pseudoregnesii West & G. S. West, Alg. Madag. 1895 (Oct.), p. 59, t. 6, f. 42; Notes Rec. Publ. Desm. 1896, p. 336.
C. montanum Schmidle in Nuova Notarisia 1897, p. 66; West & G. S. West, Alg. S. England, 1897, p. 487.
C. montanum Schmidle var. *Pseudoregnesii* (West) Borge, Süsswasseralgen Süd-Patagon. 1901, p. 22.

Cells slightly larger, often with a narrower isthmus; semicells with three protuberances, one central and one a little smaller within each lateral margin; vertical view with a conspicuous protuberance in the middle on each side, and a smaller one on each side just below each pole.

Length 10·9–15·5 μ; breadth 10·1–13·5 μ; breadth of isthmus 4·6–6·5 μ; thickness 5·4–7·7 μ.

England.—Pilmoor, N. Yorks! Riccall Common, E. Yorks! Epping Forest, Essex!
Geogr. Distribution.—Germany. Poland. Galicia. Sweden. Madagascar. Patagonia.

This variety, which unfortunately received three different names much about the same time, is primarily distinguished from the typical *C. Regnesi* by the three protuberances on each side of the vertical view. It is the largest variety of *C. Regnesi*, and the semicells are almost invariably eight-toothed. Although the extreme form of this variety is so distinct as to have been regarded as a separate species, yet all intermediate states exist between it and the type. The extent to which the protuberances are developed varies greatly, even in specimens from the same locality. In some examples they are very prominent and conspicuous, but in others they are scarcely discernible. Some of these intermediate forms are figured on Pl. LXVIII, figs. 32–34.

Note.—The Desmid described as *Euastrum crenulatum*

Bennett, 'Alg. N. Cornwall,' 1887, p. 17, t. 4, f. 20, 21; Cooke, 'Brit. Desm.' 1887, p. 187, t. 65, f. 3; De Toni, 'Syll. Alg.,' 1889, p. 1074 (*Helierella crenulata* Kuntze, 'Revis. gen. plant.,' 1891, p. 898) is most probably identical with *C. Regnesi* var. *montanum*. Bennett's figure (fig. 20) of the front view leaves little doubt of this. His fig. 21 we can only regard as quite erroneous.

70. **Cosmarium cymatonotophorum** West.

(Pl. LXVIII, figs. 37–39.)

Cosmarium cymatonotophorum West, Alg. Engl. Lake Distr. 1892, p. 726, t. 9, f. 23; Nordst. Index Desm. 1896, p. 96; West & G. S. West, Alg. S. England, 1897, p. 487.

Cells very small, about as long as broad, fairly deeply constricted, sinus widely open, conical with an obtuse apex; semicells transversely rectangular, sides subtruncate or slightly retuse, apex broadly truncate (very slightly convex) with four small undulations, all the angles slightly rounded. Side view of semicell subcircular, with a papilla at the middle on each side. Vertical view elliptic, ratio of axes about 1 : 2·3, with a prominent papilla at the middle on each side. Cell-wall smooth. Chloroplast axile, with a central pyrenoid.

Zygospore unknown.

Length 13·5–14·5 μ; breadth 13·5–14·5 μ; breadth of isthmus 5·5–6 μ; thickness 9·8 μ.

England.—Hawkshead, Lancs! Thursley Common, Surrey! New Forest, Hants!

Ireland.—Lakes between Clifden and Roundstone, Galway!

This minute species is exceedingly rare and appears to be confined to some of the old *Sphagnum*-bogs, more particularly those which surround boggy springs and which are almost impassable. It appears at first sight to closely resemble *C. Regnesi* and *C. Noræ-Semliæ*, but is easily distinguished from both these species by the greater depth of the constriction, the conical form of the sinus, and the form of the semicells. The widely rectangular semicells, with very slightly retuse sides and a 4-undulate apex, are quite

characteristic. *C. cymatonotophorum* is a minute species and is easily overlooked. It generally occurs very sparingly in a gelatinous matrix containing many other Algæ and much extraneous material.

71. **Cosmarium rectangulum** Reinsch.

(Pl. LXIX, fig. 1.)

Cosmarium rectangulum Reinsch, Contrib. Alg. et Fung. 1875, p. 89; t. 10, f. 9; De Toni, Syll. Alg. 1889, p. 1040; Roy & Biss. Scott. Desm. 1894, p. 173; Nordst. Index Desm. 1896, p. 222.
Ursinella rectangula Kuntze, Revis. gen. plant. 1891, p. 925.

Cells rather small, about as long as broad, deeply constricted, sinus rather narrow but not quite closed, slightly widened at the apex; semicells transversely rectangular, sides 3-undulate (including upper and lower angles), apex widely truncate and 4-undulate. Vertical view elliptic (?). Cell-wall smooth.

Zygospore unknown.

Length 28·5 μ; breadth 27·6 μ; breadth of isthmus 13 μ.

Scotland.—South end of Scotston Moor, Aberdeen (*Roy & Bissett*).

Geogr. Distribution.—Germany.

We have not seen this small species, but from Reinsch's figure, of which we give a copy, it seems quite distinctive. Roy states that it was only once seen from its Scottish locality.

72. **Cosmarium arctoum** Nordst.

(Pl. LXIX, fig. 2.)

Cosmarium arctoum Nordst. Desm. Arctoæ, 1875, p. 28, t. 7, f. 22; Desm. Grönland, 1885, p. 9; Freshw. Alg. N. Zeal. 1888, p. 61, t. 7, f. 29; De Toni, Syll. Alg. 1889, p. 944; Börg. Ferskv. Alg. Ostgrönl. 1894, p. 20; Roy & Biss. Scott. Desm. 1894, p. 42; Nordst. Index Desm. 1896, p. 50.
C. arctoum a. *typicum* Racib. Nonn. Desm. Polon. 1885, p. 78.
Ursinella arctoa Kuntze, Revis. gen. plant. 1891, p. 424.

Cells very small, usually about $1\frac{1}{4}$ times longer than broad, in general outline subquadrate with rounded angles and retuse sides; constriction very slight;

semicells subcuneate, with slightly diverging sides, apex truncate, straight, or very slightly convex. Side view of semicell semi-elliptic, slightly narrowed towards the base. Vertical view elliptic, ratio of axes 1 : 1·3. Cell-wall smooth and often yellowish.

Zygospore unknown.

Length 16–18 μ; breadth 12–15 μ; breadth of isthmus 10–13 μ; thickness 11–12 μ.

Scotland.—Braes of Gight, Aberdeen; Muchalls, Kincardine; Clova Table-land, Forfar (*Roy & Bissett*).

Geogr. Distribution.—Germany (var.). Galicia in Austria. Poland. Nova Zembla. Franz Joseph Land. Spitzbergen. Greenland. New Zealand. Porto Rico (var.).

The broad, flattened apices of this species are very characteristic. Nordstedt has observed a triangular variety (var. *trigonum* Nordst.) from Spitzbergen. *C. arctoum* is an essentially alpine and arctic species.

Forma **minor** West. (Pl. LXIX, figs. 3, 4.)

C. arctoum forma *minor* West, Alg. W. Ireland, 1892, p. 162, t. 24, f. 24.

Cells similar to the type, but only two-thirds the size.

Length 12·5 μ; breadth 10 μ; breadth of isthmus 8·5 μ; thickness 7·5 μ.

Ireland.—Ballynahinch, Galway!

Var. **tatricum** Racib. (Pl. LXIX, fig. 4.)

C. arctoum Nordst. var. *tatricum* Racib. Nonn. Desm. Polon. 1885, p. 78, t. 11, f. 6.

C. bicuneatum (Gay) Nordst. var. *tatricum* (Racib.) Schmidle, Lappmark Süsswasseralgen, 1898, p. 27.

Cells much smaller than in the type and more deeply constricted; angles of semicells not quite so rounded; vertical view more narrowly elliptic.

Length 9–14 μ; breadth 8–10·5 μ; breadth of isthmus 5·2–7 μ; thickness 5·6–7 μ.

England.—New Forest, Hants!

Geogr. Distribution.—N. Sweden. Poland. Silesia in Austria. New Zealand (var.).

We recorded this variety in 'Alg. S. England,' 1897, p. 491, as "a small and rather irregular form." The forms seen from the New Forest did not correspond exactly with Raciborski's Polish ones, the angles of the semicells being somewhat more rounded, and the cells, as a whole, showed slight irregularities of form. Schmidle has placed this variety under *C. bicuneatum* (Gay) Nordst., but this change we do not for the present accept. *C. bicuneatum* may be distinct from *C. arctoum* by reason of its great compression when seen from the side or vertical views, but this apparent distinction demands further inquiry. We have never seen any forms compressed in this manner, and the elliptic vertical view of var. *tatricum*, combined with its general form, indicates a very close relationship with *C. arctoum*.

73. **Cosmarium decedens** (Reinsch) Racib.

(Pl. LXIX, figs. 6–8.)

Cosmarium plicatum Reinsch ? C. *decedens* Reinsch, Spec. Gen. Alg. 1867, p. 114, t. 22, f. 7–9.
Didymidium (*Cosmarium*) *plicatum* Reinsch, Algenfl. Frank. 1867, p. 109, t. 7, f. 1 *d* [non *a*—*c*].
C. sinuosum Lund. var. *decedens* Nordst. Desm. arctoæ, 1875, p. 38, t. 8, f. 41; Desm. Ital. 1876, p. 31; De Toni, Syll. Alg. 1889, p. 894; West, Alg. W. Ireland, 1892, p. 142; Roy & Biss. Scott. Desm. 1894, p. 174; Borge, Süssw. Chlor. Archang. 1894, p. 22; West & G. S. West, Alga-fl. Yorks. 1900, p. 90.
Euastrum decedens Roy in Scott. Nat. July, 1883, p. 38.
Cosmarium decedens (Reinsch) Racib. Desm. Nowe, 1889, p. 88; Börg. Freshw. Alg. Faeroes, 1901, p. 221, t. 7, f. 9.
C. decedens Racib. b. *carpaticum* Racib. l. c. p. 88, t. 5, f. 1.
C. decedens c. *boreale* Racib l. c. p. 88.

Cells of moderate size, about twice as long as broad, moderately constricted, sinus slightly open; semicells subrectangular, sides concave, basal angles slightly protuberant, and generally closely opposed to those of the other semicell, upper angles somewhat produced and prominent, scarcely rounded, apex widely retuse. Side-view of semicell ovate-elongate. Vertical view very broadly elliptic (sub-circular), with slightly produced (faintly mammillate) poles. Cell-wall delicately punctate. Chloroplast axile with one central pyrenoid.

Zygospore unknown.

Length 40–53 μ; breadth 20–30 μ; breadth of

isthmus 14–22 μ; breadth of apex 19–28 μ; thickness 15–22 μ.

England.—Helvellyn, Westmoreland! Baildon Moor, W. Yorks!

Wales.—Near Capel Curig, Llyn-y-cwm-ffynon (at 1253 ft.), Snowdon (at 2000 ft.), and in a small ditch by Llyn Ogwen, Carnarvonshire! Dolgelly, Merioneth!

Scotland.—Vat of Culblean, Aberdeen; Den of Garrol, Kincardine (*Roy & Bissett*). Clova Tableland, Forfar! Skye in Inverness!

Ireland.—Achill Island, Mayo (at 1500 ft.)! Carrantuohill, Kerry! Slieve Donard, Down!

Geogr. Distribution.—Germany. Switzerland. Italy. Sweden. N. Russia. Poland. Faeroes. Nova Zembla.

This alpine and arctic Desmid is not infrequently met with in the boggy springs and streams of the mountainous areas of the British Isles. Its nearest allies are *C. tatricum* Racib. and *C. anceps* Lund., with both of which it should be carefully compared. The angularity and prominence of the superior angles of the semicells constitute one of its most distinctive features.

We have figured a form of it from near Capel Curig, Carnarvonshire, in which the semicells have rather more rectangular basal angles and a more deeply retuse apex (Pl. LXIX, fig. 9).

C. decedens should also be compared with *C. laticeps* Grun. (in Rabenh. 'Flor. Europ. Alg.,' III, 1868, p. 168; Nordst. 'Freshw. Alg. N. Zeal.,' 1888, p. 57, t. 6, f. 10), a small species to which it bears much resemblance. It may be that Grunow's species is but a form of *C. decedens*.

Var. **sinuosum** (Lund.) Racib. (Pl. LXIX, fig. 5.)

Cosmarium quadratum Ralfs, var. in Ralfs' Brit. Desm. 1848, t. 15, f. 1 *c*.
C. sinuosum Lund. Desm. Suec. 1871, p. 47; Wolle, Desm. U.S. 1884, p. 65, t. 16, f. 2; Roy & Biss. Scott. Desm. 1894, p. 174; Nordst. Index Desm. 1896, p. 234.
C. plicatum Reinsch, B *minus* Reinsch, Alg. Prom. Bon. Spei, 1877, p. 241.
C. plicatum Reinsch var. *sinuosum* Cooke, Brit. Desm. 1886, p. 81, t. 36, f. 4; West, Alg. N. Wales, 1890, p. 288.
Dysphinctium sinuosum (Lund.) Hansg. Prodr. Algenfl. Böhm. 1888, p. 244; De Toni, Syll. Alg. 1889, p. 894.
Cosmarium decedens a. *sinuosum* Racib. Desm. Nowe, 1889, p. 88.

This variety differs in the slightly deeper constric-

tion, the rounded superior angles of the semicells, and the smooth cell-wall.

Length 38–45 μ; breadth 18·5–22·5 μ; breadth of isthmus 13·3–16·5 μ; breadth of apex 16·5–18·2 μ; thickness 16–17·5 μ.

Wales.—Capel Curig !, and Pen-y-gwryd (*Roy*), Carnarvonshire.

Scotland.—Poolewe, Ross; Gight, Vat of Culblean and near top of Lochnagar, Aberdeen; near Cammie, Kincardine; near Oban, and near Tobermory in Mull, Argyll; Goat Fell and Glen Ranza, Arran (*Roy & Bissett*).

Geogr. Distribution.—France. Germany. Sweden. S. Russia. Nova Zembla. United States.

This variety, which is mainly distinguished from typical *C. decedens* by its rounded superior angles, is much more rarely found. It has been customary in the past to regard *C. decedens* as "var. *decedens*" of *C. sinuosum*, but we think there is every reason for reversing this. The name "*decedens*" was the first one given to this species and was undoubtedly given to the most distinctive form of it. Moreover, *C. decedens* is a generally distributed and well-known alpine and arctic Desmid, whereas its var. *sinuosum* (= *C. sinuosum* Lund.) is both uncommon and somewhat imperfectly known.

74. **Cosmarium tatricum** Racib.

(Pl. LXIX, fig. 10.)

Cosmarium tatricum Racib. Nonn. Desm. Polon. 1885, p. 78, t. 10, f. 12; De Toni, Syll. Alg. 1889, p. 1035; Roy & Biss. Scott. Desm. 1894, p. 176; Nordst. Index Desm. 1896, p. 250.
Ursinella tatrica Kuntze, Revis. gen. plant. 1891, p. 925.

Cells of moderate size, about $1\frac{2}{5}$ longer than broad, moderately constricted, sinus narrow with a dilated apex; semicells truncate-pyramidate, sides and apex concave, lower and upper angles broadly rounded. Side view of *cell* narrowly elliptic, without any median constriction. Vertical view elliptic, ratio of axes about 1 : 1·7. Cell-wall very densely and very minutely punctate-scrobiculate.

Zygospore unknown.

Length 37 μ; breadth 22 μ; breadth of apex 15·5 μ; breadth of isthmus 14 μ; thickness 15 μ.

Wales.—Bog above Capel Curig Lakes, Carnarvonshire!

Scotland.—Plankton of Loch nan Cuinne, Sutherland (*J. Murray*)! Glen Nevis, Inverness! Poolewe, Ross (*Roy & Bissett*).

Geogr. Distribution.—Silesia in Austria. Poland.

This species differs from *C. decedens* in its narrower apices, the more rounded angles of the semicells, and in the dense punctulation of the cell-wall. We have not seen the side view of the type form, but, from Raciborski's description and figures, one of its peculiarities seems to be the entire absence of a constriction in this view of the cell. As a rule, the presence or absence of punctulations cannot be considered in the light of a specific character, but the punctulation of *C. tatricum* is of such a peculiar nature that it furnishes a good character for the easy recognition of the species. The punctulations in this case are really minute scrobiculations or small cavities in the exterior of the cell-wall; they are exceedingly dense, and give the entire cell-wall the appearance of being minutely areolated.

Var. **novizelandicum** Nordst. (Pl. LXIX, figs. 11, 12.)

Cosmarium tatricum var. *novizelandicum* Nordst. in Botan. Notis. 1887, p. 161; Freshw, Alg. N. Zeal. 1888, p. 56, t. 6, f. 6; West, Alg. Engl. Lake Distr. 1892, p. 723.

A larger variety with relatively longer cells, with the basal angles of the semicells subrectangular; cells in side view with a slight but distinct constriction.

Length 46–54 μ; breadth 25–36 μ; breadth of apex 18–22 μ; breadth of isthmus 14–20 μ; thickness 12–16 μ.

England.—Kirk Fell, Cumberland!

Wales.—Llyn Bochlwyd, Carnarvonshire!

Geogr. Distribution.—New Zealand.

This variety is distinguished by the subrectangular basal angles of the semicells and by the slight constriction in the side view.

Var. **sphæruliferum** West. (Pl. LXIX, fig. 13.)

C. tatricum var. *sphæruliferum* West, Alg. W. Ireland, 1892, p. 142, t. 20, f. 19.

A larger variety with about seven small scrobiculations within the margin of each semicell and three near the isthmus; cells in side view distinctly constricted in the middle.

Length 45 μ; breadth 25 μ; breadth of apex 18·5 μ; breadth of isthmus 15 μ; thickness 14 μ.

Ireland.—Lough Shannacloontippen, Galway!

In the constricted lateral view of the cell var. *sphæruliferum* agrees with the preceding variety, but the small scrobiculations are distinctive and the basal angles are rounded.

75. **Cosmarium anceps** Lund.

(Pl. LXIX, figs. 14–17.)

Cosmarium anceps Lund. Desm. Suec. 1871, p. 48, t. 3, f. 4; Nordst. Desm. Spetsb. 1872, p. 36; Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 39; Cooke, Brit. Desm. 1886, p. 82, t. 36, f. 8; West, Alg. N. Yorks. 1889, p. 292; Alg. N. Wales, 1890, p. 288; Alg. W. Ireland, 1892, p. 143; Alg. Engl. Lake Distr. 1892, p. 724; Lütkem. Desm. Attersees, 1893, p. 549; Roy & Biss. Scott. Desm. 1894, p. 41; Nordst. Index Desm. 1896, p. 44; G. S. West, Alga-fl. Cambr. 1899, p. 114; West & G. S. West, Alga-fl. Yorks. 1900, p. 90; Alg. N. Ireland, 1902, p. 32; Freshw. Alg. Orkneys and Shetlands, 1905, p. 22.

Dysphinctium anceps (Lund) Hansg. Prodr. Algenfl. Böhm. 1888, pp. 187, 278; De Toni, Syll. Alg. 1889, p. 893.

D. anceps forma *glabra* Gutw. Nonn. Alg. Nov. 1896, p. 43, t. 7, f. 35 *c*, *d*.

Cells small, almost twice as long as broad, longitudinally oblong-hexagonal, only moderately constricted, sinus slightly open and not deep; semicells truncate-pyramidate, sides very slightly concave (almost straight), apex truncate and slightly retuse-emarginate, upper and lower angles rounded. Side view of semicell ovate. Vertical view very broadly elliptic with slightly produced (submammillate) poles, ratio of axes about 1 : 1·3. Cell-wall smooth. Chloroplast axile with one central pyrenoid.

Zygospore unknown.

Length 25–35 μ; breadth 14·5–19 μ; breadth of

apex 10–14 μ; breadth of isthmus 8–12 μ; thickness 10·5–14 μ.

England.—Near Bowness (*Bissett*), and Helvellyn!, Westmoreland. Ogden Clough, Holden Ghyll near Keighley, Penyghent, and Cowgill Wold Moss, Widdale Fell, W. Yorks! Mickle and Cronkley Fells, N. Yorks! Chippenham Fen, Cambridge! Enbridge Lake, Hants (*Roy*).

Wales.—Ffestiniog and Llyn-an-afon, Carnarvonshire!

Scotland.—Ross, Inverness, Banff, Aberdeen, Kincardine, Forfar!, Perth!, and Stirling (*Roy & Bissett*). Orkneys!

Ireland.—Ballynahinch and Loch Aunierin, Galway! Slieve Donard, Down! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Austria and Galicia. Italy. Norway. Sweden. Bornholm. Poland (var.). Faeroes. Nova Zembla. Spitzbergen. Greenland. United States.

C. anceps is a very characteristic alpine and subalpine species, occurring associated with *C. Holmiense*, *C. tetragonum* var. *Lundellii*, *C. speciosum*, *C. galeritum*, *C. ochthodes*, and certain other species, among mosses on the dripping rocks of mountain glens, and in the boggy springs high up on the mountains. In West Yorkshire it is generally found on the dripping sandstone and grit rocks in the ghylls and glens, and also in the springs on the Millstone Grit above the limestone. A curious anomaly in its distribution was its abundant occurrence in August, 1898, in a ditch in Chippenham Fen, Cambridgeshire.

C. anceps is nearly allied to *C. decedens*, from which it can be distinguished by its somewhat smaller size, its narrower apices with less prominent apical angles, and by the straighter (less retuse) sides of the semicells.

Gutwinski ('Nonn. Alg. Nov.,' 1896, p. 43) has described a "forma *punctata*" and a "forma *angusta*" of this species, but the latter form is scarcely deserving of a special name as the relative proportions of this species are variable within limits which would include such a form.

Forma **crispula** Nordst. (Pl. LXVI, fig. 17A.)

Cosmarium anceps Lund. forma Nordst. Norges Desm. 1873, p. 24.
C. anceps forma *crispula* Nordst. Desm. Arctoæ, 1875, p. 38.
C. tetragonum (Näg.) Arch. var. *pumilum* West & G. S. West, New Brit. Freshw. Alg. 1894, p. 5, t. 1, f. 19.
Dysphinctium parvulum (Bréb.) Schmidle var. *undulatum* Schmidle, Beitr. alp. Alg. 1895, p. 348, t. 15, f. 7 [*vide* Nordst. Index Desmid. 1896, pp. 44 and 197; West & G. S. West in Journ. Bot. Sept. 1898.
D. anceps forma *crispula* in Gutw. Nonn. Alg. Nov. 1896, p. 44, t. 7, f. 36.
Cosmarium parvulum Bréb. var. *pumilum* West & G. S. West, Alga-fl. Yorks. 1900, p. 95.

Generally smaller than typical *C. anceps*, with the basal angles of the semicells obscurely subrectangular and the sides slightly undulate (one median crest and two hollows).

Length 22·5–38 μ; breadth 12·5–20 μ; breadth of isthmus 7·5–12 μ.

England.—Near Ilkley, W. Yorks!

Scotland.—Craig-an-Lochan, Perthshire!

Geogr. Distribution.—Tyrol. Norway. Nova Zembla.

The exact relationship of this form has been a matter of considerable doubt. We are now of the opinion that it is more nearly allied to *C. anceps* than to *C. parvulum* or *C. tetragonum*.

Schmidle has stated ("Zur Kritik einiger Süsswasseralgen," 'Nova Notarisia,' 1897, p. 70) that *C. doliforme* West & G. S. West ('Some N. Amer. Desm.,' 1896, p. 246, t. 15, f. 16) is only a form of his "*Dysphinctium parvulum* var. *undulatum*," but this is not so, as *C. doliforme* is more nearly related to *C. pseudopyramidatum* Lund. than to any other Desmid.

76. **Cosmarium obliquum** Nordst.
(Pl. LXIX, figs. 18–21.)

Cosmarium obliquum Nordst. Norges Desm. 1873, p. 23, t. 1, f. 8 [forma *minor*, forma *media*, forma *major*]; Cooke, Brit. Desm. 1886, p. 94, t. 43, f. 5; Nordst. Freshw. Alg. N. Zeal. 1888, pp. 57, 80; De Toni, Syll. Alg. 1889, p. 959; West, Alg. N. Yorks. 1889, p. 292; Heimerl, Desm. alp. 1891, p. 600; West, Alg. W. Ireland, 1892, p. 149; Alg. Engl. Lake Distr. 1892, p. 726; Lütkem. Desm. Attersees, 1893, p. 548; Roy & Biss. Scott. Desm. 1894, p. 169; Nordst. Index Desm. 1896, p. 184; West & G. S. West, Alg. S. England, 1897, p. 487; Alga-fl. Yorks. 1900, p. 91; Freshw. Alg. Orkneys and Shetlands, 1905, p. 22.
Nothocosmarium obliquum (Nordst.) Racib. Desm. Nowe, 1889, p. 98, t. 6, f. 13.
Ursinella obliqua Kuntze, Revis. gen. plant. 1891, p. 925.

Cells small, a little longer than broad, subrectangular, only moderately constricted, sinus rather open; semicells transversely subrectangular, sides slightly retuse, apex straight, very slightly concave, or very slightly convex, upper and lower angles rectangular but rounded. Side view of *cells* very slightly constricted, constriction deeper on one side than the other, semicells subquadrate. Vertical view strongly convex on one side and straight or slightly retuse on the other, poles broadly rounded. Cell-wall finely punctate. Chloroplast axile with a central pyrenoid.

Zygospore unknown.

Length 14–27 μ; breadth 11–24 μ; breadth of isthmus 10–16 μ; thickness 9·5–15 μ.

England.—Langdale and Bowness, Westmoreland! Hawkshead and Risley Bog (*Roy*), Lancashire! Cullingworth, Malham Tarn Bog, Penyghent, Oughtershaw Tarn (forma *major*), and Mossdale Moor, Widdale Fell, W. Yorks! Mickle, Lunds, and Widdale (at 2000 ft.) Fells, Snaizedale Beck and Birkdale Tarn Moss, N. Yorks! Subfossil in peat deposit at Filey, E. Yorks! Chobham Common, Surrey!

Wales.—Snowdon (above 3000 ft.)!, and Pen-y-gwryd (*Roy*), Carnarvonshire.

Scotland.—Sutherland!, Ross, Inverness!, Aberdeen, Kincardine, Forfar, Perth!, Argyll, Arran (*Roy & Bissett*). Lewis and Harris, Outer Hebrides! Orkneys!

Ireland.—Creggan Lough and Lakes east of Lough Bofin, Galway! Carrantuohill, Kerry! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Austria and Galicia. Hungary. Portugal. Norway. Sweden. Finland. N. Russia. Nova Zembla. New Zealand. Azores. W. Indies.

C. obliquum is mostly met with on dripping subalpine rocks, at the margins of peaty pools, and in the peat bogs of upland areas. It does, however, occur in the bogs of heaths and ancient commons, and in the damp climate of Dominica it has

been found amongst various hepatics on trees (at 4500 ft.) in a matrix consisting mostly of subaerial blue-green Algæ.

It varies much in size and the forms have been arranged in three groups as follows:—

1. Forma *minor* Nordst. Length 14–15·5 μ; breadth 11–13 μ.

2. Forma *media* Nordst. Length 18·5 μ; breadth 13 μ.

3. Forma *major* Nordst. Length 23–27 μ; breadth 18–24 μ. (Pl. LXXII, fig. 39).

Intermediate sizes occur between these three forms, and the full range of measurements is given after the description.

C. obliquum is a well-marked species by reason of its slight constriction and the zygomorphic character of the vertical view. The side view is also characteristic owing to the truncate apices and the inequality of the faint constriction on the two sides. It stands nearest to *C. Norimbergense* Reinsch, to which species it has been proposed to refer it as "forma *obliqua*." We think, however, that the characters of *C. obliquum* are such as to warrant complete separation as a species. It is less deeply constricted than *C. Norimbergense*, and the characters of its side and vertical views are peculiar.

Forma **minima** West. (Pl. LXIX, figs. 22, 23.)

C. obliquum forma *minima* West, Alg. Engl. Lake Distr. 1892, p. 726, t. 9, f. 15.

Cells minute and proportionately longer than in the type.

Length 11–14 μ; breadth 8–9 μ; breadth of isthmus 4·2–5 μ; thickness 4·4–6·5 μ.

England.—Helvellyn and Pike of Bliscoe, Westmoreland!

Geogr. Distribution.—Norway.

Var. **trigonum** West. (Pl. LXIX, fig. 24.)

C. obliquum var. *trigonum* West, Alg. W. Ireland, 1892, p. 149, t. 24, f. 15.

A small variety with the semicells from the vertical view trigonal, sides almost straight, angles rounded.

Length 17·5 μ; breadth 14 μ; breadth of isthmus 8·5 μ.

Ireland.—Carrantuohill, Kerry!

77. **Cosmarium Norimbergense** Reinsch.

(Pl. LXIX, figs. 25–27.)

Cosmarium Norimbergense Reinsch, Spec. Gen. Alg. 1867, p. 117, t. 22 A iv, f. 1–11; Lund. Desm. Suec. 1871, p. 43; De Toni, Syll. Alg. 1889, p. 960; Roy & Biss. Scott. Desm. 1894, p. 169; Nordst. Index Desm. 1896, p. 183; West & G. S. West, Freshw. Alg. Ceylon, 1902, p. 166.

C. Hammeri Reinsch f. D. *octogibbosum* Reinsch, Spec. Gen. Alg. 1867, p. 115, t. 22 B i, f. 13–19.

Didymidium (*Cosmarium*) *Norimbergense* Reinsch, Algenfl. Frank. 1867, p. 113, t. 9, f. 2.

Cosmarium octogibbosum Reinsch, Alg. Prom. Bon. Spei, 1877, p. 240; Turn. Freshw. Alg. E. India, 1893, p. 52.

C. Meneghinii Bréb. var. *Wollei* Lagerh. Desm. aus Bengal, 1888, p. 8 [*C. Meneghinii* Wolle, Desm. U. S. 1884, t. 16, f. 7 sinistra superior]; West, Alg. W. Ireland, 1892, p. 149, t. 24, f. 18 [forma monstrosa]; West & G. S. West, Alg. S. England, 1897, p. 487; Alga-fl. Yorks. 1900, p. 93.

Ursinella Norimbergensis Kuntze, Rev. gen. plant. 1891, p. 925.

Cosmarium octogibbosum Reinsch var. *indica* Turn. Freshw. Alg. E. India, 1893, p. 52, t. 8, f. 8.

Cells small, about $1\frac{1}{2}$ times as long as broad, deeply constricted, sinus narrow with a dilated apex; semicells subquadrate, sides retuse, upper and lower angles rounded, apex retuse, almost straight, or very slightly convex. Side view of semicell oblong-elliptic. Vertical view elliptic, ratio of axes 1 : 1·6. Cell-wall smooth. Chloroplast axile with a single central pyrenoid.

Zygospore unknown.

Length 12–23 μ; breadth 8–13·3 μ; breadth of isthmus 3–5·5 μ; thickness 6·7–9 μ.

England.—Riccall Common, E. Yorks! Dartmoor, Devonshire!

Wales.—Yr Orsedd, Carnarvonshire!

Scotland.—Slewdrum, Aberdeen; marsh N. W. from Menmuir Church, Forfar (*Roy & Bissett*).

Ireland.—Roundstone, Galway! Cromagloun, Upper Lake of Killarney, and Carrantuohill, Kerry!

Geogr. Distribution.—Germany. Hungary. Sweden. Bornholm. Finland. India (var.). Ceylon. Siam. New Zealand. Central Africa.

This small species is nearly related to *C. obliquum* Nordst., and perhaps to *C. exiguum* Arch.

Forma **depressa** West & G. S. West. (Pl. LXIX, figs. 28, 29.)

C. Norimbergense Reinsch forma *depressa* West & G. S. West, Welw. Afric. Freshw. Alg. 1897, p. 119; Freshw. Chlorophy. Koh Chang, 1901, p. 175.

Cells about as long as broad, semicells depressed. Length 11–15·5 μ; breadth 11–14 μ; breadth of isthmus 3·5–5 μ.

Ireland.—Small lakes between Clifden and Roundstone, and Lough Derryclare, Galway!

Geogr. Distribution.—Ceylon. Burma. Siam. Central Africa.

Another form of this species, as yet not found in the British Islands, is forma *elongata* West & G. S. West ('Welw. Afric. Freshw. Alg.,' 1897, p. 119, t. 368, f. 4, 5; *C. exiguum* Arch. var. *Norimbergense* Schmidle, in 'Flora, lxxviii, 1894, p. 56, t. 7, f. 17). This form is almost twice as long as broad and the upper angles of the semicells are not quite so rounded: length 16–18 μ; breadth 9·5 μ; breadth of isthmus 3 μ; thickness 7 μ.

78. **Cosmarium repandum** Nordst.

(Pl. LXIX, fig. 30.)

Cosmarium repandum Nordst. in Botan. Notis. 1887, p. 162; Freshw. Alg. N. Zeal. 1888, p. 58, t. 6, f. 14; Mask. Further Notes New Zeal. Desm. 1889, p. 16, t. 2, f. 21; De Toni, Syll. Alg. 1889, p. 971; Nordst. Index Desm. 1896, p. 224.
Ursinella repanda Kuntze, Revis. gen. plant. 1891, p. 925.

Cells of medium size, about $1\frac{1}{4}$ times longer than broad, deeply constricted, sinus narrowly linear with a dilated apex; semicells transversely trapezoid-oblong, widest above their middle, sides distinctly divergent, lower angles obtuse, apex arched from the widest part of the semicell where the upper angles are broadly rounded, usually flattened at the middle of the arch. Side view of semicell subcircular. Vertical view elliptic, ratio of axes about 1 : 1·5, poles rounded, but when viewed obliquely (and especially from the base)

tricrenate-dentate. Cell-wall very finely punctate. Chloroplast axile with two pyrenoids.

Zygospore unknown.

Length 40–44 μ; breadth 35–45 μ; breadth of isthmus 12–17 μ; thickness 24–26 μ.

Geogr. Distribution.—New Zealand. W. Africa.

The typical form is not known to occur in the British Islands.

Forma **minor** West & G. S. West. (Pl. LXIX, figs. 31, 32.)

Cosmarium odontopleurum Arch. in Roy & Biss. Scott. Desm. 1894, p. 169, t. 2, f. 13; Nordst. Index Desm. 1896, p. 188.
C. repandum Nordst. forma *minor* West & G. S. West, Some Desm. U. S. 1898, p. 303.

Cells half or less than half the size of the type, with the three crenations absent from the oblique view of the basal angles.

Zygospore globose and smooth.

Length 15–22 μ; breath 14–20 μ; breadth of isthmus 5·5–8 μ; diam. zygosp. 30 μ.

Scotland.—Powlair, Aboyne; Homehead, Aberdeen (*Roy & Bissett*).

Ireland.—Dublin and Wicklow (*Archer*).

Geogr. Distribution.—United States.

79. **Cosmarium rectangulare** Grun.

(Pl. LXX, figs. 1, 2.)

Cosmarium rectangulare Grun. in Rabenh. Flor. Europ. Algar. III, 1868, p. 166; De Toni, Syll. Alg. 1889, p. 987; West, Alg. W. Ireland, 1892, p. 146; Alg. Engl. Lake Distr. 1892, p. 725; Gutw. Flor. glonów Galic. 1892, p. 129; Flor. Glon. Okolic Tarnopola, 1894, p. 92; Roy & Biss. Scott. Desm. 1894, p. 173; West & G. S. West, Alg. S. England, 1897, p. 486; Some Desm. U. S. 1898, p. 302; Alga-fl. Yorks. 1900, p. 91; Alg. N. Ireland, 1902, p. 34.
Cosmarium gotlandicum Wittr. Gotl. Öl. sötv. Alg. 1872, p. 60, t. 4, f. 14; Nordst. Norges Desm. 1873, p. 19; Cooke, Brit. Desm. 1886, p. 88, t. 37, f. 4; West, Alg. N. Wales, 1890, p. 288; Johns. Rare Desm. U. S. II, 1895, p. 293, t. 240, f. 26.
Ursinella rectangularis Kuntze, Revis. gen. plant. 1891, p. 925.

Cells of medium size, about $1\frac{1}{4}$ times as long as

broad, deeply constricted, sinus very narrow with a dilated apex; semicells subhexagonal-reniform, basal angles subrectangular and rounded, sides parallel (in the lower part), upper angles broadly and obliquely rounded-truncate, apex truncate and straight. Side view of semicell obovate-circular. Vertical view subelliptic, ratio of axes about 1 : 1·4. Cell-wall finely punctate.

Zygospore unknown.

Length 37–47 μ; breadth 30–36 μ; breadth of isthmus 9–12 μ; thickness 18–24 μ.

England.—Blea Tarn, Westmoreland! Hawkshead, Lancashire! Mickle Fell and Pilmoor, N. Yorks! Skipwith Common, E. Yorks! Chobham Common, Esher Common, and Devil's Jumps, Surrey!

Wales.—Capel Curig and Llyn-y-cwm-ffynon, Carnarvonshire!

Scotland.—Loch Inver, Sutherland; near Tain, Ross; Loch Ruthven, Inverness; Slewdrum, Achverran, and Glen Callater, Aberdeen; Cammie, Bishops' Dam, and Clochnaben, Kincardine; Mull, Argyll (*Roy & Bissett*). Rhiconich, Sutherland! Glen Shee, Perth! Lewis, Harris, and N. Uist, Outer Hebrides!

Ireland.—Mayo! Galway! Kerry! Donegal! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—Germany. Austria and Galicia. Norway. Sweden. Bornholm. Poland. Greenland. Siberia. Japan. Central Africa (var.). United States. W. Indies (form).

This is a well-marked species easily distinguished by the rectangular basal angles and the obliquely truncate upper angles of the semicells. Gutwinski gives the following range of measurements for Austrian specimens: Length 27·6–51 μ; breadth 25·3–44 μ; breadth of isthmus 6·9–14 μ.

Var. **cambrense** (Turn.) West & G. S. West. (Pl. LXX, fig. 3.)

C. gotlandicum Wittr. var. *cambrense* Turn. Desm. Notes, 1893, p. 345, f. 7 (p. 344).

C. rectangulare Grun. var. *cambrense* (Turn.) West & G. S. West, Alg. Centr. Africa, 1896, p. 379.

Cells proportionately longer, about $1\frac{1}{2}$ times longer than broad.

Length 35 μ; breadth 22 μ; breadth of isthmus 6 μ.

Wales.—Bog near Dolbadarn Castle, Carnarvonshire (*J. H. Lewis*).

Var. **hexagonum** (Elfv.) *nob.* (Pl. LXX, fig. 4.)

C. hexagonum Elfv. Anteck. Finska Desm. 1881, p. 12, t. 1, f. 8; Hansg. in Sitzungsber. d. k. böhm. Ges. d. Wiss. 1892, p. 131.
C. Elfvingii Racib. Nonn. Desm. Polon. 1885, p. 83; De Toni, Syll. Alg. 1889, p. 953; West, Alg. W. Ireland, 1892, p. 145.
Ursinella Elfvingii Kuntze, Revis. gen. plant. 1891, p. 924.

Rather smaller; cells proportionately shorter, about as long as broad.

Length 28–30 μ; breadth 24–27 μ; breadth of isthmus 7–8 μ; thickness 15 μ.

Ireland.—Near Clifden, Galway!

Geogr. Distribution.—Finland. Poland. Central China (form). Brazil (form).

C. Elfvingii Racib ["*C. hexagonum* Elfv."] possesses no characters of sufficient importance to separate it from *C. rectangulare* Grun. It scarcely differs from the latter in any respect other than its proportionately shorter cells. The two varieties which have been described of *C. Elfvingii* are referable to other species. "*C. Elfvingii* var. *saxonicum* Racib." ('Desm. Nowe,' 1889, p. 780, t. 5, f. 14) is without doubt identical with *C. pseudoprotuberans* Kirchn. var. *angustius* Nordst. ('Freshw. Alg. New Zeal.,' 1888, p. 58, t. 6, f. 15, 16). "*C. Elfvingii* var. *altius* Schmidle" (in 'Hedwigia,' xxxiv, 1895, p. 84 cum fig.), by reason of the narrowness of its apices, its elevated semicells, and the slightly retuse character of their superior lateral margins, seems to us to be a form of *C. granatum* Bréb.

The Desmid described and figured by Borge ('Beiträge Alg. Schweden,' 1906, p. 39, t. 2, f. 26) as "*C. pseudoprotuberans* Kirchn. forma minor dorso semicellulæ paullum truncato" is only a form of *C. rectangulare* Grun. var. *hexagonum* nob.

80. **Cosmarium subquadratum** Nordst.

(Pl. LXX, fig. 5.)

Cosmarium subquadratum Nordst. Desm. Ital. 1876, p. 32, t. 12, f. 7; De Toni, Syll. Alg. 1889, p. 968; Hansg. in Sitzungsber. d. k. böhm. Ges. d. Wiss. 1892, p. 133; West & G. S. West, Alga-fl. Yorks. 1900, p. 90.
Ursinella subquadrata Kuntze, Revis. gen. plant. 1891, p. 925.

Cells of about medium size, about twice as long as broad, deeply constricted, sinus very narrow, slightly dilated at the apex; semicells subquadrate, sides parallel for more than half way upwards, sometimes very slightly upwardly divergent, or faintly retuse, basal angles rectangular and a little obtuse, upper angles widely and obliquely convex-truncate, apex truncate or sometimes subretuse. Side view of semicell ovate. Vertical view elliptic, ratio of axes about 1:1·5. Cell-wall finely and densely scrobiculate-punctate. Chloroplast single, axile, and with a central pyrenoid.

Zygospore unknown.

Length 52–56 μ; breadth 29–32 μ; breadth of apex about 8 μ; breadth of isthmus 12–14 μ; thickness 19–22 μ.

England.—Among various Algæ on dripping rocks, Ingleton, W. Yorks!

Geogr. Distribution.—France. Italy. Brazil.

81. **Cosmarium quadratum** Ralfs.

(Pl. LXX, figs. 6—8).

Cosmarium quadratum Ralfs in Ann. Mag. Nat. Hist. 1844, p. 395, t. 11, t. 9; Ralfs, Brit. Desm. 1848, p. 92, t. 15, f. 1*a* [figure incorrect]; Kütz. Spec. Alg. 1849, p. 175; Arch. in Pritch. Infus. 1861, p. 731; Rabenh. Flor. Europ. Algar. III, 1868. p. 162; Lund. Desm. Suec. 1871, p. 47; Wolle, Desm. U. S. 1884, p. 59, t. 18, f. 10 [figs. 8 and 9?]; Cooke, Brit. Desm. 1886, p. 80, t. 36, f. 2; West, Alg. N. Wales, 1890, p. 288; Heimerl, Desm. alp. 1891, p. 596; Borge, Chlor. Norska Finmark. 1892, p. 11; West, Alg. W. Ireland, 1892, p. 142; Alg. Engl. Lake Distr. 1892, p. 723; Lütkem. Desm. Attersees, 1893, p. 555; Roy & Biss. Scott. Desm. 1894, p. 173; Borge, Sverig. Chlorophy. II, 1895, p. 17; Nordst. Index Desm. 1896, p. 217; West & G. S. West, Alg. S. England, 1897, p. 485; G. S. West. Alga-fl. Cambr. 1899, p. 114; West & G. S. West, Alga-fl. Yorks. 1900, p. 90; Alg. N. Ireland, 1902, p. 32; Freshw. Alg. Orkneys and Shetlands, 1905, p. 22.

Euastrum (*Cosmarium*) *quadratum* Näg. Gatt. einz. Alg. 1849, p. 114.
Didymidium (*Cosmarium*) *quadratum* Reinsch, Algenfl. Frank. 1867, p. 113.
Cosmarium quadratum a. *genuinum* Kirchn. Alg. Schles. 1878, p. 146.
Dysphinctium quadratum (Ralfs) Hansg. Prodr. Algenfl. Böhm. 1888, p. 244; De Toni, Syll. Alg. 1889, p. 882; Schmidle, Beitr. Algenfl. Schwarzwald. u. Rheineb. 1893, p. 25; Weit. Beitr. Algenfl. Rheineb. u. Schwarzwald. 1895, p. 72.

Cells of medium size, about twice as long as broad, with a fairly deep constriction, sinus narrow at the apex but somewhat open towards the exterior; semicells subquadrate, slightly narrowed upwards, basal angles rounded, sides slightly retuse, upper angles broadly rounded, apex convex. Side view of semicell ovate or elliptic-pyramidate. Vertical view elliptic, ratio of axes 1 : 1·4. Cell-wall smooth. Chloroplast axile, with two pyrenoids, and usually with four (or more) somewhat irregular (but on the whole) longitudinally-disposed plates.

Zygospore unknown.

Length 48–64 μ; breadth 25–37 μ; breadth of isthmus 12–23 μ; thickness 18–28 μ.

England.—Westmoreland! (*Bissett*). Cumberland! Lancashire! W. N. and E. Yorks! Essex! Cambridgeshire! Oxfordshire! Surrey! Kent! Hants! Wilts! Devon! Cornwall! Monmouth!

Wales.—Snowdon (up to 3000 ft.), Moel Siabod, Llyn Bochlwyd, Llyn Idwal, Llyn Gwynant, Llyn Cwlyd, Y Foel Fras, and Yr Orsedd, Carnarvonshire! Dolgelly, Merioneth!

Scotland.—Sutherland!, Ross, Inverness, Banff, Aberdeen!, Kincardine, Forfar!, Perth!, Argyll!, Fife (*Roy & Bissett*). Orkneys! Shetland! General in the Outer Hebrides!

Ireland.—Donegal! Mayo! Galway! Kerry! Londonderry! Down (up to 2000 ft. on Slieve Donard and Slieve Commedagh)! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Austria and Galicia. Norway. Sweden. Denmark. Bornholm. Finland. Russian Lapland. N. Russia. S. Russia. Faeroes. Iceland. Nova Zembla. Spitzbergen.

Siberia. Greenland. New Zealand (form). United States. W. Indies. Patagonia (form).

C. quadratum is a characteristic species with a wide distribution, but is of much more general occurrence in the uplands than in the lowlands, especially in the *Sphagnum* bogs. The basal angles of the semicells are rounded, and are very slightly turgid and protruding. This character, the slightly open sinus, the retuse sides of the semicells, and the axile chloroplasts, distinguish *C. quadratum* from *C. Cucumis*, a species with which it should be compared.

We figure one individual with a slight irregularity in the chloroplasts (Pl. LXXXVII, fig. 19). The chloroplast of one semicell is normal in the possession of two pyrenoids, but that of the other semicell possesses three pyrenoids.

Forma **Willei** *nob.* (Pl. LXXXVII, figs. 21, 22.)

Cosmarium quadratum Ralfs forma "*semicellulæ lateribus nonnunquam latissime rotundatis l. rectis nec retusis*" Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 37, t. 12, f. 20, 21 [inclus. f. *major* Wille]; Boldt. Siber. Chlorophy. 1885, p. 100; Desm. Grönland, 1888, p. 10; Borge, Süssw. Chlor. Archang. 1894, p. 23.

Dysphinctium quadratum (Ralfs) Hansg. var. *Willei* Schmidle, Beitr. Algenfl. Schwarzwald. u. Rheineb. 1893, p. 91, t. 4, f. 1, 2.

Sides of semicells straight or slightly convex.

Length 50–76 μ; breadth 30–46 μ; breadth of isthmus 16·8–27 μ; thickness 27–36 μ.

England.—Helvellyn, Westmoreland! Mickle Fell, N. Yorks!

Ireland.—Jar Connaught, Galway! Carrantuohill, Kerry!

Geogr. Distribution.—Nova Zembla. Greenland. N. Russia. Siberia.

Var. **angustatum** *var. nov.* (Pl. LXXXVII, fig. 20.)

Cells proportionately narrower, about $2\frac{1}{3}$ times longer than broad, sinus rather more open.

Length 70 μ; breadth 30 μ; breadth of isthmus 20 μ; thickness 25·5 μ.

England.—Woodbury Common, near Exeter, Devonshire! (*R. Morgan*).

82. **Cosmarium plicatum** Reinsch.

(Pl. LXX, figs. 9, 10.)

Cosmarium plicatum Reinsch, Spec. Gen. Alg. 1867, p. 114, t. 22, f. C. II; Cooke, Brit. Desm. 1886, p. 81, t. 36, f. 3; West, Alg. N. Wales, 1890, p. 288; Heimerl, Desm. alp. 1891, p. 596; West, Alg. Engl. Lake Distr. 1892, p. 723; Roy & Biss. Scott. Desm. 1894, p. 171; Nordst. Index Desm. 1896, p. 202; West & G. S. West, Alga-fl. Yorks. 1900, p. 90.
Didymidium (*Cosmarium*) *plicatum* Reinsch, Algenfl. Frank. 1867, p. 109, t. 9, f. 1 *a–c*.

Cells moderately large, about $1\frac{2}{3}$–$1\frac{4}{5}$ as long as broad, fairly deeply constricted, sinus narrow with a slightly dilated apex; semicells truncate-pyramidate, sides slightly convex, rarely almost straight, both lower and upper angles rounded, apex slightly convex. Side view of semicell elliptic. Vertical view elliptic, ratio of axes about 1 : 1·6. Cell-wall minutely and densely punctate.

Zygospore unknown.

Length 48–61 μ; breadth 26–35 μ; breadth of isthmus 16·5–18 μ.

England.—Near Blea Tarn, Cumberland! Blubberhouses (*W. B. Turner*) and Adel Bog!, W. Yorks. Mickle and Great Shunnor Fells, N. Yorks!

Wales.—Snowdon, Llyn Bochlwyd, and Llyn Idwal, Carnarvonshire!

Scotland.—Ross; Brin, Inverness; Brimmond and Dalbargie, Aberdeen; Pitreddie and Curran, Kincardine; Methen Bog, Perth (*Roy & Bissett*).

Ireland.—Dublin and Wicklow (*Archer*).

Geogr. Distribution.—Germany. Sweden.

C. plicatum is nearest to *C. quadratum*, but differs in the more rectangular semicells, with convex sides, and in the closed sinus.

Forma **major** Reinsch. (Pl. LXX, fig. 11.)

C. plicatum forma A. *majus* Reinsch. Spec. Gen. Alg. 1867, p. 114, t. 22, f. C. II, 10.
C. plicatum var. *majus* Reinsch (?) in Roy & Biss. Scott. Desm. 1894, p. 171, t. 2, f. 1.

Length 87–92 μ; breadth 48–50 μ; breadth of isthmus 22 μ.

Scotland.—Powlair in Birse, Aberdeen; Scolty near Banchory, Kincardine (*Roy & Bissett*).

Geogr. Distribution.—Germany.

Var. **hibernicum** West. (Pl. LXX, figs. 12, 13.)

C. plicatum Reinsch var. *hibernicum* West, Alg. W. Ireland, 1892, p. 142, t. 24, f. 9; Schröder, Beitr. Algen Riesengebirges, 1898, p. 35.
C. plicatum var. *Scoticum* Roy & Biss. Scott. Desm. 1894, p. 171, t. 2, f. 2. [*Vide* West & G. S. West, Rec. publ. Desm. 1895, p. 67.]
C. Holmiense Lund. var. *hibernicum* (West) Schmidle, Alg. Bern. Alp. 1894, p. 95.

Larger than the type, sides of semicells slightly hollowed below the apex, apical angles a little prominent, and apex strongly convex in the middle.

Length 88–96 μ; breadth 47–52 μ; breadth of isthmus 17–21 μ.

Scotland.—The Vat, Presswhin (Cromar), Aberdeen (*Roy & Bissett*). Lewis, Outer Hebrides!

Ireland.—Achill Island, Mayo! Carrantuohill, Kerry!

Geogr. Distribution.—Germany. Switzerland.

This characteristic variety is apparently very scarce in the mountainous districts of Scotland and Ireland. Roy and Bissett say it is a rupestral species, but we have found it mostly in the boggy springs on the mountains of the west coasts. Schmidle, in 1894, placed the variety under *C. Holmiense* Lund., but although it undoubtedly connects *C. plicatum* with *C. Holmiense* var. *integrum* Lund., yet it is much nearer *C. plicatum* than *C. Holmiense*. This relationship is made sure on examining a number of specimens of *C. plicatum*.

83. **Cosmarium Debaryi** Arch.

(Pl. LXX, figs. 14–16; Pl. XCIII, fig. 2.)

Pleurotænium cosmarioides De Bary, Conj. 1858, p. 75, t. 5, f. 32, 33; Bulnh. in Hewigia, 1859, p. 21, t. 2, f. 8; Rabenh. Flor. Europ. Alg. III, 1868, p. 144; p. 104 (cum fig. xylogr.).
Cosmarium Debaryi Arch. in Pritch. Infus. 1861, p. 735; Lund. Desm. Suec. 1871, p. 52; Kirchn. Alg. Schles. 1878, p. 146; West, Alg. W. Ireland, 1892, p, 164; Alg. Engl. Lake Distr. 1892, p. 730; Roy & Biss. Scott. Desm. 1894, p. 45; Nordst. Index Desm. 1896, p. 97; West & G. S. West, Alga-fl. Yorks. 1900, p. 90; Alg. N. Ireland, 1902, p. 42.

C. Thwaitesii Ralfs b. *majus* Rabenh. Flor. Europ. Alg. III, 1868, p. 175; Wittr. Skandinav. Desm. 1869, p. 14, t. 1, f. 5.
C. Debaryi a. *typicum* Klebs, Desm. Ostpreuss. 1879, p. 28, t. 3, f. 4*b*.
Calocylindrus Debaryi Wolle, Freshw. Alg. U. S. 1887, p. 27, t. 56, f. 12 Cooke, Brit. Desm. 1887, p. 128, t. 44, f. 4; West, Alg. N. Wales, 1890, p. 291.
Cosmaridium Debaryi Hansg. Prodr. Algenfl. Böhm. 1888, p. 246; Heimerl, Desm. alp. 1891, p. 595.
Pleurotæniopsis Debaryi De Toni, Syll. Alg. 1889, p. 906; Lütkemüller, Chlorophyllkörper Desm. 1893, p. 47, t. 3, f. 25; Desm. Attersees, 1893, p. 548.

Cells large, about twice as long as broad (or rather more), moderately constricted, sinus open and acute; semicells subquadrate, sides subparallel, straight, slightly convex or even faintly retuse, basal angles rectangular but rounded, apical angles broadly rounded, apex truncate-convex or convex. Vertical view almost circular, very slightly compressed. Cell-wall very minutely punctate. Chloroplasts parietal and band-like, about five in each semicell, each band with numerous small and rather irregular lobes pressed against the inner side of the cell-wall, and with 2–4 pyrenoids; central part of each semicell occupied by a rather conspicuous hyaline vacuole.

Zygospore unknown.

Length 100–112 μ; breadth 46–54 μ; breadth of isthmus 27·5–39 μ; thickness 46–50 μ.

England.—Angle Tarn, Cumberland! Brothers' Water!, Scandale!, Loughrigg!, and near Bowness (*Bissett*), Westmoreland. Adel Bog, W. Yorks! Pilmoor, N. Yorks! Sub-fossil in peat deposit at Filey, E. Yorks! Near the Lizard, Cornwall!

Wales.—Capel Curig and Llyn Bodgynwydd, Carnarvonshire!

Scotland.—Inverness, Aberdeen, Kincardine, Perth! (*Roy & Bissett*). Kircudbright! Lewis, Outer Hebrides!

Ireland.—Near Glenties, Lough Anna, and near Lough Magrath, Donegal! Near Westport, Mayo! Ballynahinch and Derryclare Lough, Galway! Lough Guitane and near Lough Brin, Kerry! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—Germany. Austria. Norway.

Sweden. Denmark. Bornholm. N. Russia. Nova Zembla. Spitzbergen. United States. Brazil.

C. Debaryi is an uncommon species which should be carefully compared with *C. quadratum* and *C. plicatum*. Apart from differences of external form and proportions, it is somewhat larger than either of these species and differs signally in the nature of its chloroplasts. There are about five parietal chloroplasts in each semicell, often more or less united towards the apex, and somewhat peculiar in the possession of numerous, small, peripheral lobes. These chloroplasts are similar in general features to those of *C. tesselatum* (Delp.) Nordst., but are more irregular (*vide* Lütkemüller, 'Chlorophyllkörper Desm.,' 1893, t. 3, f. 22–25). In the centre of each semicell is a vacuole, which often stands out so conspicuously as to give the appearance of a large central pyrenoid.

84. **Cosmarium exiguum** Arch.

(Pl. LXX, fig. 17–19.)

Cosmarium exiguum Arch. in Proc. Dubl. Nat. Hist. Soc. 1864, p. 49, t. 1, f. 32, 33; Rabenh. Flor. Europ. Alg. III, 1868, p. 164; Lund. Desm. Suec. 1871, p. 43; Cooke, Brit. Desm. 1886, p. 92, t. 43, f. 4; Nordst. Freshw. Alg. N. Zeal. 1888, p. 58, t. 6, f. 12; De Toni, Syll. Alg. 1889, p. 954; West, Alg. N. Wales, 1890, p. 289; Alg. W. Ireland, 1892, p. 147; Alg. Engl. Lake Distr. 1892, p. 725; Roy & Biss. Scott. Desm. 1894, p. 101; Nordst. Index Desm. 1896, p. 121; West & G. S. West, Welw. Afric. Freshw. Alg. 1897, p. 36; G. S. West, Alga-fl. Cambr. 1899, p. 217; West & G. S. West, Alg. N. Ireland, 1902, p. 34.
Ursinella exigua Kuntze, Revis. gen. plant. 1881, p. 924.
Cosmarium quadratulum (Gay) De Toni forma *javanica* Gutw. Alg. Ins. Java, 1902, p. 590, t. 38, f. 31.

Cells small, about twice as long as broad, fairly deeply constricted, sinus somewhat open; semicells subquadrate with the angles rounded, sides and apex almost straight or very slightly convex. Side view of semicell broadly elliptic. Vertical view elliptic, ratio of axes about 1 : 1·4. Cell-wall smooth. Chloroplasts axile, one in each semicell, each with a central pyrenoid.

Zygospore unknown.

Length 14·5–29 μ; breadth 9·5–15 μ; breadth of isthmus 3–6 μ; thickness 7–10 μ.

England.—Risley Bog, S. Lancashire (*Roy*), Delamere, Cheshire (*Roy*), Chippenham Fen, Cambridge!

Wales.—Capel Curig !, Llyn-y-cwm-ffynon !, Glyder Fawr (*Roy*), and Pen-y-gwryd (*Roy*), Carnarvonshire.

Scotland.—General, but scarce ! (*Roy & Bissett*). Common in the Outer Hebrides !

Ireland. — Donegal ! Galway ! Kerry ! Down ! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—Germany. Galicia. Norway. Sweden. Poland. Siam. India. Ceylon. West Africa. New Zealand. Abyssinia. United States. Paraguay. Patagonia (form).

C. exiguum is a rather uncommon species of very characteristic form. It has a wide distribution in bogs and swamps. The largest forms are those mentioned by Nordstedt from New Zealand as "forma paulo major": length 32–36 μ; breadth 22 μ; breadth of isthmus 6–6·5 μ. The same author also describes a trigonal form (*vide* 'Freshw. Alg. N. Zeal.,' 1888, p. 58, t. 6, f. 13). A form from Michigan, U. S. A., with more rounded semicells, had a length of 41 μ and a breadth of 24 μ; *vide* West & G. S. West, 'Some Desm. U. S.,' 1898, p. 303.

Var. **pressum** West & G. S. West. (Pl. LXX, figs. 23, 24.)

C. exiguum Arch. var. *pressum* West & G. S. West, New Brit. Freshw. Alg. 1894, p. 6, t. 1, f. 1.

A smaller variety with proportionately narrower cells, semicells slightly narrowed from base to apex, and with slightly retuse apices.

Length 12·5–14·5 μ; breadth 5·8–6·5 μ; breadth of isthmus 3·5–4·5 μ; thickness 5 μ.

England.—Elter Water, Cumberland !

Var. **subrectangulum** *var. nov.* (Pl. LXX, figs. 20–22.)

Cells proportionately broader; sinus closed, linear with a dilated apex; semicells transversely subrectangular.

Length 14·5 μ–15 μ; breadth 10·7–11·5 μ; breadth of isthmus 2·2–3·2 μ; thickness 7 μ.

England.—Chippenham Fen, Cambridgeshire !

85. **Cosmarium pseudoexiguum** Racib.

(Pl. LXX, figs. 25, 26.)

Cosmarium (Pleurotæniopsis) pseudoexiguum Racib. Nonn. Desm. Polon. 1885, p. 71, t. 10, f. 8 [in descrip. of plate "*C. subexiguum*"]; Nordst. Index Desm. 1896, p. 208; West & G. S. West, Alg. N. Ireland, 1902, p. 34; Freshw. Alg. Ceylon, 1902, p. 166; Freshw. Alg. Orkneys and Shetlands, 1905, p. 22.

Pleurotæniopsis pseudoexigua (Racib.) Lagerh. Algol. Bidr. II, 1887, p. 198.

Cosmaridium pseudoexiguum (Racib.) Hansg. Prodr. Algenfl. Böhm. 1888, p. 246 [in note].

Cells small, rather more than twice as long as broad, very deeply constricted, sinus narrowly linear with a dilated extremity; semicells subquadrate (longitudinally subrectangular), basal angles slightly rounded, sides slightly convex, upper angles broadly rounded, apex generally slightly convex, rarely straight or very faintly retuse. Side view of semicell subelliptic. Vertical view elliptic, ratio of axes 1 : 1·6. Cell-wall smooth. Chloroplasts parietal.

Zygospore unknown.

Length 19–25·7 μ; breadth 7–13·6 μ; breadth of isthmus 3·8–4 μ; thickness 5–8·5 μ.

Wales.—Moel Siabod, Carnarvonshire!

Scotland.—Rhiconich, Sutherland! Near Lerwick, Shetlands!

Ireland.—Errigal, near Glenties, and Sproule's Lough, Donegal! Lough Fea, Londonderry! Shanslieve, Down!

Geogr. Distribution.—Galicia in Austria. Poland. Ceylon. Porto Rico.

This tiny species differs from *C. exiguum* Arch. in its relatively greater length, its much deeper constriction, its closed sinus, and in the possession of parietal chloroplasts. Although we have obtained this species from several localities we have not yet examined any living specimens, and we have not been able to satisfactorily make out the disposition of the chloroplasts, which were described by Raciborski as parietal.

Var. **angustatum** *var. nov.* (Pl. LXX, fig. 27.)

C. pseudoexiguum Racib. forma in West & G. S. West, Alga-fl. Yorks. 1900, p. 91.

Cells proportionately narrower; semicells slightly attenuated from base to apex; constriction *very* deep, isthmus very narrow. Side and vertical views more compressed.

Length 18 μ; breadth 7·7 μ; breadth of isthmus 1·5 μ; thickness 4·8 μ.

England.—Strensall Common, N. Yorks!

86. **Cosmarium minimum** West & G. S. West.

(Pl. LXXI, figs. 1, 2.)

Cosmarium minimum West & G. S. West, Alg. Madag. 1895, p. 58, t. 8, f. 10; Nordst. Index Desm. 1896, p. 171; West & G. S. West, Welw. Afric. Freshw. Alg. 1897, p. 118; Alga-fl. Yorks. 1900, p. 91; Freshw. Alg. Ceylon, 1902, p. 166.

Cells minute, a little longer than broad, fairly deeply constricted, sinus sublinear and slightly open; semicells transversely rectangular, angles scarcely rounded, sides and apex almost straight. Side view of semicell subcircular. Vertical view elliptic, ratio of axes about 1 : 1·7. Cell-wall smooth. Chloroplasts axile with a small central pyrenoid.

Zygospore unknown.

Length 8·4–10·5 μ; breadth 7·2–9 μ; breadth of isthmus 3-5 μ; thickness 4·5–5·5 μ.

England.—Pilmoor, N. Yorks!

Geogr. Distribution.—Ceylon. Madagascar. W. Africa.

This minute species is characterized by its rectangular semicells. It has principally a tropical distribution.

87. **Cosmarium pusillum** (Bréb.) Arch.

(Pl. LXXI, figs. 3, 4.)

Euastrum pusillum Bréb. Liste Desm. 1856, p. 125, t. 1, f. 7.

Cosmarium pusillum (Bréb.) Arch. in Pritch. Infus. 1861, p. 731; Rabenh. Flor. Europ. Alg. III, 1868, p. 169; Kirchn. Alg. Schles. 1878, p. 153; Hansg. Prodr. Algenfl. Böhm. 1888, p. 201; Boldt, Desm. Grönland, 1888, p. 17; De Toni, Syll. Alg. 1889, p. 1045; Roy & Biss. Scott. Desm. 1894, p. 172; Nordst. Index Desm. 1896, p. 214; West & G. S. West, Alg. N. Ireland, 1902, p. 34; Freshw. Alg. Ceylon, 1902, p. 166.

Ursinella pusilla Kuntze, Revis. gen. plant. 1891, p. 925.

Cosmarium pusillum var. *retusum* Turn. forma Turn. Freshw. Alg. E. India, 1893, p. 71, t. 10, f. 26.

Cells minute, about as long as broad or a little broader, deeply constricted, sinus slightly open; semicells transversely pyramidate-rectangular, sides very slightly convex, converging upwards, basal angles slightly rounded, apex widely retuse, upper angles scarcely rounded. Side view of semicell subcircular. Vertical view elliptic, ratio of axes about 1 : 1·6. Cell-wall smooth. Chloroplasts axile with a small central pyrenoid.

Zygospore unknown.

Length 6·8–9·6 μ; breadth 7–9·6 μ; breadth of isthmus 2·7–4·8 μ; thickness 4·5–5·5 μ.

Wales.—Llyn Bochlwyd!, Llyn Bodgynwydd!, Capel Curig!, Snowdon (*Roy*), and Bettws-y-coed (*Roy*), Carnarvonshire.

Scotland.—Near Loch Coruisk in Skye, Inverness; near Berse Church, Cavinton Moss, near Aboyne, Homehead in Cromar, Aberdeen; Scolty Dam, Cammie, Kincardine; Glen Clova and Clova Tableland, Forfar (*Roy & Bissett*).

Ireland.—Lough Cloncarney, Donegal! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Silesia. Greenland. Bengal. Ceylon. Siam.

The distinctive features of this minute species are the widely pyramidate semicells with slightly convex sides and retuse apex. It appears to have been much confused with other small species of the genus. The small *Cosmarium* described and figured by W. B. Turner ('Freshw. Alg. E. India,' 1893, p. 71, t. 10, f. 25) as "*C. pusillum* var. *retusum*" is most probably one of the minute forms of *Cosmarium Hammeri*. To the latter species also belongs "*C. pusillum* var. *retusum* forma *intermedia*" Gutw. ('Flor. Glon. Okolic. Tarnapola,' 1894, p. 100, t. 3, f. 37).

88. **Cosmarium geometricum** West & G. S. West.

(Pl. LXXI, figs. 5, 6.)

Cosmarium geometricum West & G. S. West, Alg. Madag. 1895, p. 58, t. 6, f. 32; Nordst. Index Desm. 1896, p. 129; West & G. S. West, Alg. S. England, 1897, p. 486.

Cells minute, about as long as broad, deeply constricted, sinus open but acute; semicells broadly truncate-pyramidate, sides straight (or very faintly concave), angles acute, the upper ones faintly subapiculate, apex widely concave, in the centre of the semicell with a papilla. Side view of semicell subcircular, with a papilla at the middle on each side. Vertical view elliptic, with apiculate poles and a papilla at the middle on each side, ratio of axes (without the papillæ) 1 : 2. Cell-wall smooth. Chloroplasts axile with a small central pyrenoid.

Zygospore unknown.

Length 9·5–10·5 μ; breadth 9·5–10·5 μ; breadth of isthmus 2 μ; thickness 6 μ.

England.—Puttenham Common, Surrey!

Geogr. Distribution.—Madagascar.

This minute species should be compared with *C. Sinostegos* Schaarschm. and its var. *obtusius* Gutw., from which Desmids it differs in the form of its basal angles, the apiculate apical angles, and in the concave apex.

89. **Cosmarium helcangulare** Nordst.
(Pl. LXXI, fig. 7.)

Cosmarium helcangulare Nordst. Bornh. Desm. 1888, p. 199, t. 6, f. 16–18; De Toni, Syll. Alg. 1889, p. 960; Gutw. Flor. Glon. Okolic Tarnapola, 1894, p. 87, t. 3, f. 44; Nordst. Index Desm. 1896, p. 138; West & G. S. West, Alg. S. England, 1897, p. 486 [printer's error "*hexangulare*"].
Ursinella helcangularis Kuntze, Revis. gen. plant. 1891, p. 924.

Cells minute, a little longer than broad, deeply constricted, sinus narrow but slightly open; semicells transversely rectangular - trapeziform, sides almost straight, slightly diverging upwards, lower angles rounded, upper angles produced upwards into submamillate processes, apex in the middle truncate or slightly convex. Side view of semicell subcircular. Vertical view elliptic, ratio of axes about 1 : 2. Cell-wall smooth.

Zygospore unknown.

Length 11·5–14 μ; breadth 11·5–12 μ; breadth of isthmus 4·4–5·4 μ; thickness 6–7·4 μ.

England.—Thursley Common, Surrey!

Geogr. Distribution.—Germany. Galicia in Austria, Bornholm.

C. helcangulare is allied to *C. Norimbergense*, but is at once distinguished by the straight sides of the semicells and the upwardly produced superior angles.

90. **Cosmarium coarctatum** West.

(Pl. LXXI, fig. 8.)

Cosmarium coarctatum West, Alg. Engl. Lake Distr. 1892, p. 724, t. 9, f. 11; Nordst. Index Desm. 1896, p. 76.

Cells small, a little longer than broad, moderately constricted, sinus somewhat open and obtuse; semicells obtrapeziform, lateral margins almost straight and slightly diverging upwards, apex broadly truncate, straight, angles slightly rounded. Side view of semicell subcircular from a flattened base, apex subtruncate. Vertical view elliptic, ratio of axes about 1 : 1·7. Cell-wall smooth, somewhat thickened at each apex.

Zygospore unknown.

Length 16 μ; breadth at base of semicells 12–12·5 μ, at apex 13·5–14·4 μ; breadth of isthmus 7 μ; thickness 8 μ.

England.—Borrowdale, Cumberland!

This species is closely related to *C. contractum* var. *cracoviense* Racib., but is much smaller, has more truncate apices, a relatively wider isthmus, and a different side view.

91. **Cosmarium protuberans** Lund.

(Pl. LXXI, fig. 9.)

Cosmarium protuberans Lund. Desm. Suec. 1871, p. 37, t. 3, f. 17; De Toni, Syll. Alg. 1889, p. 1006; Roy & Biss. Scott. Desm. 1894, p. 172; Nordst. Index Desm. 1896, p. 207.

Cells small, a little longer than broad, deeply constricted, sinus narrow and linear; semicells subtrapeziform, sides diverging upwards, lower angles obtuse, upper angles rounded, apex convex, with a finely and

densely scrobiculate tumour just below the middle of the apex. Side view of semicell obversely subsemicircular, with convex apex and rounded angles. Vertical view narrowly oblong, with a finely scrobiculate tumour at the middle on each side, ratio of axes about 1 : 1·3 (with the inflations). Cell-wall (apart from the central tumours) finely punctate. Chloroplasts axile with a central pyrenoid.

Zygospore unknown.

Length 24 μ; breadth 22–23 μ; breadth of isthmus 6–7 μ; thickness 16–18 μ.

Scotland.—Bottomend, near Aboyne, Aberdeen (*Roy & Bissett*).

Geogr. Distribution. — France. Germany (var.). Galicia in Austria (var.). Sweden. Bornholm. Poland. United States (var.).

The central protuberance, which Lundell describes as "granulate," is really finely scrobiculate, and these small depressions are situated so close together as to give the margin of the protuberance quite a rough appearance when seen in vertical view. *C. protuberans* appears to be a very rare species.

The Desmid mentioned and figured by Wille ('Norges Ferskv. Alg.' 1880, p. 33, t. 1, f. 18) as a form of *C. pseudoprotuberans* Kirchn. is only a large form of *C. protuberans* Lund.

Forma **paludosa** *f. nov.* (Pl. LXXI, fig. 10.)

C. protuberans Lund. forma G. S. West, Alga-fl. Cambr. 1899, p. 116, t. 394, f. 12.

Cells more deeply constricted, apex of sinus more conspicuously ampliated, and the protuberances in the vertical view considerably reduced.

Length 22–23 μ; breadth 19–21 μ; breadth of isthmus 5·2 μ; thickness 12 μ.

England.—In ditches, Chippenham Fen, Cambridgeshire!

The cell-wall of this form is minutely scrobiculato-punctate as in the type.

92. **Cosmarium sphagnicolum** West & G. S. West.

(Pl. LXXI, figs. 11–14.)

Cosmarium sphagnicolum West & G. S. West, Alg. S. England, 1897, p. 486, t. 6, f. 13, 14; Obs. on Conj. 1898, p. 52, t. 4, f. 34–36; Alga-fl. Yorks. 1900, p. 91; Alg. N. Ireland, 1902, p. 34; Notes Alg. III, 1903, p. 10 (sep.); Freshw. Alg. Orkneys and Shetlands, 1905, p. 22.

Cells minute, about as long as broad or a little broader, moderately constricted, sinus short and open; semicells subtrapeziform, sides straight and divergent upwards, lower angles obtuse, upper angles obliquely truncate, apex broad, straight or very slightly retuse, within each truncate upper angle furnished with a minute papilla. Side view of semicell subcircular. Vertical view elliptic, poles bluntly pointed, ratio of axes about 1 : 2, with a minute papilla on each side near the poles. Cell-wall smooth. Chloroplasts axile, one in each semicell, each with a single pyrenoid.

Zygospore unknown.

Length 10·5–11·5 μ; breadth 11–13·5 μ; breadth of isthmus 5–5·5; thickness 6·5 μ.

England.—Cocket Moss, near Giggleswick, and Mossdale Moor, Widdale Fell, W. Yorks! Mickle Fell, N. Yorks! Thursley Common, Surrey!

Wales.—Llyn Bochlwyd, Llyn Teyrn on Snowdon, and Y Foel Fras, Carnarvonshire!

Scotland.—Finstown, Orkneys!

Ireland.—Near Glenties and near Gweedore, Donegal! Lough Fea, Londonderry!

This minute species sometimes occurs in immense quantity amongst *Sphagnum* in small, peaty pools, associated with *C. Cucurbita*. It is most nearly related to *C. pygmæum* Arch., a species which often occurs in equal abundance in similar situations. In the vertical view *C. sphagnicolum* and *C. pygmæum* cannot be distinguished from each other, but the former is much less deeply constricted than the latter, and its semicells are of a different form. We have never found these two species intermingled, but as they occur in great abundance in similar situations we consider them as very closely related; perhaps they should be regarded as established forms of one species.

93. **Cosmarium truncatellum** Perty.

(Pl. LXXI, figs. 15, 16.)

Euastrum (*Cosmarium*) *truncatellum* Perty in Mittheil. d. naturforsch. Ges. in Bern, 1849, p. 173; Kleinst. Lebensf. 1852, p. 209, t. 16, f. 13.
Cosmarium truncatellum Perty; Rabenh. Flor. Europ. Alg. III, 1868, p. 165; Arch. in Quart. Journ. Micr. Sci. 1873, p. 99; Joshua in Journ. Bot. xx, 1882, p. 301; Racib. Nonn. Desm. Polon. 1885, p. 23 (sep.); Cooke, Brit. Desm. 1886, p. 91, t. 37, f. 9; De Toni, Syll. Alg. 1889, p. 1017; West, Alg. N. Wales, 1890, p. 288; Alg. W. Ireland, 1892, p. 147; Roy & Biss. Scott. Desm. 1894, p. 177; Nordst. Index Desm. 1896, p. 261; West & G. S. West, Alg. S. England, 1897, p. 486; Alga-fl. Yorks. 1900, p. 92.
Ursinella truncatella Kuntze, Revis. gen. plant. 1891, p. 926.

Cells minute, about $1\frac{1}{3}$ times broader than long, deeply constricted, sinus open and acute-angled; semicells transversely oblong-hexagonal, lateral angles bluntly conical, the short sides above the sinus converging upwards into the broad flat truncate apex. Side view of semicell subcircular. Vertical view fusiform-elliptic, ratio of axes about 1 : 3. Cell-wall smooth.

Zygospore globose, furnished with numerous sharp spines.

Length 9·5–10·5 μ; breadth 12·5–14·5 μ; breadth of isthmus 5·5 μ; thickness 5 μ.

England.—Risley Bog, Lancashire (*Roy*). Strensall Common, N. Yorks. (*W. B. Turner*). Chobham Common, Surrey!

Wales.—Bethesda! and Capel Curig! (*Cooke & Wills*), Carnarvonshire.

Scotland.—Ross, Inverness, Aberdeen, Kincardine, Forfar. Zygospores from Aboyne, Aberdeen; Dalbrake, Kincardine; Ninhaven, Forfar (*Roy & Bissett*). Perth!

Ireland.—Moher Lough, Galway! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—Germany. Switzerland. Galicia in Austria. Norway. Poland. United States.

This species is characterized by the form of its semicells and its open sinus. The narrowly fusiform vertical view is also a noteworthy feature. The zygospores have been

observed by Archer, Joshua, and Roy, but as these authors have not published figures of them, and we ourselves have never observed them, we are unfortunately only able to give a description of them. *C. truncatellum* sometimes occurs in considerable quantity amongst submerged *Sphagnum*.

94. **Cosmarium subcapitulum** West.

(Pl. LXXII, fig. 17.)

Cosmarium subcapitulum West, Alg. Engl. Lake Distr. 1892, p. 725, t. 9, f. 20; Nordst. Index Desm. 1896, p. 244.

Cells small, a little broader than long, deeply constricted, sinus open, triangular and subacute; semicells transversely oblong-hexagonal, upper and lower part of sides converging outwards to form an angle a little less than a right angle, apex broad and very slightly retuse. Side view of semicell circular-elliptic. Vertical view fusiform-elliptic, poles subacute, ratio of axes about 1 : 3. Cell-wall smooth.

Zygospore unknown.

Length 17 μ; breadth 19 μ; breadth of isthmus 4 μ; thickness 7·5 μ.

England.—Near Bowness, Westmoreland!

This species differs from *C. Capitulum* Roy & Biss. (consult page 119) in the truncate and subretuse apices, in the acute lateral angles of the semicells, in the form of the sinus (which is not acuminate), and in the subacute poles of the vertical view.

95. **Cosmarium pygmæum** Arch.

(Pl. LXXI, figs. 22–31.)

Cosmarium pygmæum Arch. in Quart. Journ. Micr. Sci. 1864, p. 174, t. 6, f. 45–49; Wittr. Skandinav. Desm. 1869, p. 26; Cooke, Brit. Desm. 1886, p. 91, t. 37, f. 8 [figure bad]; De Toni, Syll. Alg. 1889, p. 1046; West, Alg. N. Wales, 1890, p. 288; Alg. W. Ireland, 1892, p. 146, t. 20, f. 24; Lütkem. Desm. Attersees, 1893, p. 550; Roy & Biss. Scott. Desm. 1894, p. 173; Nordst. Index Desm. 1896, p. 214; West & G. S. West, Alg. S. England, 1897, p. 486; Alga.-fl. Yorks. 1900, p. 92; Alg. N. Ireland, 1902, p. 34; Freshw. Alg. Orkneys and Shetlands, 1905, p. 22.

Sphærozosma pygmæum Rabenh. Flor. Europ. Alg. III, 1868, p. 150. [This is not "*Sphærozosma pygmæum* Cooke," Brit. Desm. 1886, p. 5, t. 2, f. 5.]

Cosmarium Schliephackianum Grun. in Rabenh. Flor. Europ. Alg. III,

1868, p. 167; Kirchn. Alg. Schles. 1878, p. 153; Cooke, Brit. Desm. 1886, p. 92; De Toni, Syll. Alg. 1889, p. 1046.
Ursinella pygmæa Kuntze, Revis. gen. plant. 1891, p. 925.
U. Schliephackiana Kuntze, l.c. p. 925.
Cosmarium minutissimum Heimerl, Desm. alp. 1891, p. 600, t. 5, f. 14 [not *C. minutissimum* Arch., 1877]; consult Lütkem. Desm. Mills-tättersees, 1900, p. 11.
C. Heimerlii West & G. S. West, Rec. publ. Desm. 1895, p. 5 (sep.); Alg. S. England, 1897, p. 486.
C. Heimerlii var. *tumidum* West & G. S. West, Notes Alg. I, 1898, p. 4 (sep.); Alga-fl. Yorks. 1900, p. 91.
C. pygmæum Arch. var. *Schliephackianum* (Grun.) West & G. S. West, Some Desm. U. S. 1898, p. 302; Alg. N. Ireland, 1902, p. 34.

Cells minute, as long as broad, or slightly broader than long, deeply constricted, sinus narrow and linear; semicells somewhat variable in form, commonly transversely oblong-rectangular, more rarely oblong-hexagonal, basal angles obtuse, upper angles commonly very slightly obliquely truncate, lateral angles often minutely mucronate (almost produced into a papilla), apex widely truncate, straight or convex, rarely very slightly retuse, with a scarcely conspicuous protuberance in the middle of each semicell, and a minute papilla (sometimes absent) within each lateral angle. Side view of semicell subcircular, with or without a prominence at the middle of each side. Vertical view elliptic, generally somewhat umbonate at the middle on each side, and with a minute papilla (rarely absent) on each side near the poles. Cell-wall smooth. Chloroplasts one in each semicell, axile, with a small central pyrenoid.

Zygospore globose, subglobose, or oblong-globose, smooth.

Length 7–12 μ; breadth 7–12·5 μ; breadth of isthmus 2–5·5 μ; thickness 5·5–6·5 μ; diam. zygosp. 13–15 μ.

England. — Helvellyn, Westmoreland! (*Bissett*). Ribblehead, Cowgill Wold Moss on Widdale Fell, Ingleborough, and Greetland, W. Yorks! Mickle Fell and Lund's Fell, N. Yorks! Delamere, Cheshire (*Roy*). Leicestershire (*Roy*). Near Chapel Wood and Thursley Common, Surrey! Keston Common, Kent! Hants (*Roy*).

Wales.—Capel Curig and Llyn-y-cwm-ffynon, Carnarvonshire!

Scotland.—Sutherland!, Ross, Inverness!, Moray, Banff, Aberdeen, Kincardine, Forfar, Perth!, Fife, Stirling, Dumbarton, Argyll, and Arran. Zygospores from Folotry, Perth (*Roy & Bissett*). Orkneys and Shetlands! Common in the Outer Hebrides!

Ireland.—Donegal! Lough Aunierin, Galway (with zygospores)! Near Lough Brin, Lower Lake of Killarney, and Lough Guitane (with zygospores), Kerry! Dublin and Wicklow (*Archer*). Armagh! Slieve Donard, Down!

Geogr. Distribution.—France. Germany. Austria. Silesia in Austria. Norway. Sweden. Denmark. Bornholm. Poland. Faeroes. Greenland. Japan. India. Ceylon. United States. Patagonia. Australia.

C. pygmæum is a species which is almost confined to *Sphagnum*-bogs and to small peaty pools with an abundance of submerged *Sphagnum*. In these situations it sometimes occurs in countless millions, and pure collections of it can easily be made. It is a Desmid about which there has been much misunderstanding in the past, possibly owing to its minute size and its variability. Dr. Lütkemüller has found the species abundantly in Austria, and he is in complete agreement with us regarding its synonymy. We are likewise indebted to him for drawings of his Austrian specimens, some of which we have reproduced.

In external form the semicells exhibit much variation, and the same remark applies to the median protuberances and papillæ of the vertical view. The most widely distributed form has an oblong-rectangular semicell, in which the upper angles are somewhat obliquely truncate, and the lateral angles thus formed are faintly produced into a minute mucro. This same form in vertical view has a median protuberance and two papillæ on each side. We have refrained from any attempt to arrange the forms as all possible gradations exist between the extremes figured on Pl. LXXI.

It is probable that *C. silesiacum* Gutw. ('Wahr. d. Priorität,' 1890, p. 69; 'Flor. Glom. Okolic Lwowa,' 1891, p. 55) should be placed as one of the forms of *C. pygmæum*, but an examination of the specimens is necessary to decide the question.

96. **Cosmarium polygonum** (Näg.) Arch.
(Pl. LXXI, figs. 32–34.)

Euastrum (*Cosmarium*) *polygonum* Näg. Gatt. einz. Alg. 1849, p. 120, t. 7A, f 9.

Cosmarium polygonum (Näg.) Arch. in Pritch. Infus. 1861, p. 732; Rabenh. Flor. Europ. Alg. III, 1868, p. 167; Wolle, Desm. U.S. 1884, p. 65, t. 16, f. 30; West, Desm. Maine, 1888, p. 340; De Toni, Syll. Alg. 1889, p. 949; Heimerl, Desm. alp. 1891, p. 600; Roy & Biss. Scott. Desm. 1894, p. 171.

Ursinella polygona Kuntze, Revis. gen. plant. 1891, p. 925.

? *Cosmarium minutum* Benn. Freshw. Alg. S. W. Surrey, 1892, p. 10, t. 2, f. 11.

Cells small, a little longer than broad, fairly deeply constricted, sinus rather short and narrow; semicells broadly hexagonal, angles rounded, lateral ones very slightly produced, sides faintly retuse (apex of semicell sometimes straight). Side view of semicell depressed-circular, slightly inflated at each side. Vertical view subelliptic, with a prominent, somewhat conical tumour at the middle of each side, ratio of axes about 1 : 1·6. Cell-wall smooth or rarely finely punctate. Chloroplasts axile with a central pyrenoid.

Zygospore unknown.

Length 15–21·5 μ; breadth 14–18·5 μ; breadth of isthmus 3–7 μ; thickness 10–12·5 μ.

Scotland.—Sutherland, Ross, Aberdeen, Kincardine, Forfar, Argyll, Fife (*Roy & Bissett*).

Ireland.—Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Sweden. Burma. Madagascar. United States.

The proportionately longer cells, the more pronounced lateral angles, and the conical tumours of the vertical view distinguish this species from *C. abbreviatum* Racib.

We have examined large forms of *C. polygonum* from Maine, U. S. A., up to 27 μ in breadth. One specimen of *C. polygonum* var. *exile* West & G. S. West ('Welw. Afric. Freshw. Alg.,' 1897, p. 117), from W. Africa, was distinctly stipitate, the stalk of attachment having its origin at one of the lateral angles of a semicell and reaching a length of 32 μ. This stalk was in no way gelatinous, but consisted of cellulose, and was a continuous part of the cell-wall of the specimen. Its diameter was about 0·5 μ. We have figured this curious specimen on Pl. XCI, fig. 13.

97. **Cosmarium pseudobiremum** Boldt.

(Pl. LXXI, fig. 35.)

Cosmarium pseudobiremum Boldt, Siber. Chlorophy. 1885, p. 102, t. 5, f. 6; De Toni, Syll. Alg. 1889, p. 1042; Gutw. Flor. Glon. Okolic Lwowa, 1891, p. 56; Roy & Biss. Scott. Desm. 1894, p. 172; Nordst. Index Desm. 1896, p. 208.
Ursinella pseudobiremis Kuntze, Revis. gen. plant. 1891, p. 925.

Cells small, a little broader than long, deeply constricted, sinus narrow; semicells transversely hexagonal-elliptic, lateral angles obtuse, superior angles broadly rounded, apex wide and almost straight (faintly convex). Side view of semicell subcircular. Vertical view narrowly elliptic, with a rather broad protuberance at the middle on each side, ratio of axes about 1 : 2. Cell-wall smooth.

Zygospore unknown.

Length 22–27 μ; breadth 28–30; breadth of isthmus 13 μ; thickness 12–14 μ.

Scotland.—Foot of Birsemore, near Aboyne, Aberdeen (*Roy & Bissett*).

Geogr. Distribution.—Greenland. Siberia.

This species should be compared with *C. abbreviatum* Racib., from which it differs in its more rounded semicells, its broader isthmus, and its tumid vertical view.

98. **Cosmarium bireme** Nordst.

(Pl. LXXI, figs. 36, 37.)

Cosmarium bireme Nordst. Desm. Brasil. 1870, p. 212, t. 3, f. 33; Norges Desm. 1873, p. 18; Wolle, Desm. U.S. 1884, p. 82, t. 19, f. 23, 24; Wille, Sydamerik. Algfl. 1884, p. 16; De Toni, Syll. Alg. 1889, p. 1033; Roy & Biss. Scott. Desm. 1894, p. 42; Nordst. Index Desm. 1896, p. 62; West & G. S. West, Freshw. Alg. Ceylon, 1902, p. 165, t. 20, f. 30.
Ursinella biremis Kuntze, Revis. gen. plant. 1891, p. 924.

Cells minute, about as long as broad, deeply constricted, sinus very narrow; semicells subellipsoid-hexagonal, basal and lateral angles obtuse, upper angles broadly rounded, apex truncate and almost straight. Side view of semicell circular, with a long papilla at the middle on each side. Vertical view elliptic, with a long and somewhat conical papilla at

the middle on each side. Cell-wall smooth. Chloroplasts axile with one small central pyrenoid.

Zygospore unknown.

Length 12–13·5 μ; breadth 10–14·5 μ; breadth of isthmus 2·5–4 μ; thickness (including papilla) 12–13 μ.

Scotland.—Spittal of Glen Shee, Perth!

Geogr. Distribution.—Germany (form). Silesia in Austria. Norway. Sweden. Bengal. Ceylon. Madagascar (var.). Abyssinia. New Zealand (form). Australia. Porto Rico. Brazil.

C. bireme is closely related to *C. polygonum*, but is distinguished by its smaller size, the different form of its semicells, and the replacement of the broad central tumours by elongated papillæ. It is mostly a tropical species, and one of its varieties (var. *barbadense* G. S. West, 'West Indian Freshw. Alg.,' 1904, p. 286, t. 464, f. 17) is amongst the smallest of known Desmids (length 7·3–7·7 μ; breadth 7·4–8 μ).

99. **Cosmarium adoxum** West & G. S. West.

(Pl. LXXI, fig. 38.)

Cosmarium adoxum West & G. S. West, Alg. S. England, 1897, p. 478, t. 7, f. 24.

Cells minute, suboctagonal, a little longer than broad, deeply constricted, sinus very narrow and slightly dilated at the apex; semicells truncate-pyramidate with obliquely truncate basal angles, lower part of sides slightly divergent, upper part of sides convergent and very slightly retuse (almost straight), apex broadly truncate and straight. Side view of semicell subcircular, with a median acute papilla on each side. Vertical view elliptic, with a subacute papilla at the middle on each side, ratio of axes (without papilla) 1 : 1·7. Cell-wall smooth. Chloroplasts axile, with a small central pyrenoid.

Zygospore unknown.

Length 10–11 μ; breadth 9·5 μ; breadth of isthmus 3 μ; thickness (without papilla) 5·3 μ.

England.—New Forest, Hants!

This minute species is nearest to *C. Sinostegos* Schaar. var. *obtusius* Gutw., but is distinguished by its proportionately greater length, by its rounder basal angles, which are also more rectangular, and by the rounded poles of the vertical view. It is very distinct from typical *C. Sinostegos*.

100. **Cosmarium Sinostegos** Schaarschm. (Pl. LXXI, fig. 39.)

Cosmarium Sinostegos Schaarschm. Magyar. Desm. 1882, p. 266, t. 1, f. 12; De Toni, Syll. Alg. 1889, p. 1043; Nordst. Index Desm. 1896, p. 234. *Ursinella Sinostegos* Kuntze, Revis. gen. plant. 1891, p. 925.

Cells minute, about $1\frac{1}{2}$ times as broad as long, deeply constricted, sinus widely open from a narrow apex; semicells subhexagonal, with the part bordering on the sinus convex, lower angles produced upwards and outwards, very acute, sides concave, upper angles not rounded, apex broadly truncate and straight. Side view of semicell circular-oblong, with truncate apices, and a papilla in the middle of each side. Vertical view elliptic-rhomboid, poles sharply acuminate, with an acutely conical papilla at the middle on each side. Cell-wall smooth. Chloroplasts axile with a central small pyrenoid.

Zygospore unknown.

Length 10 μ; breadth 14 μ; breadth of isthmus 4·3 μ; thickness (with papilla) 9 μ.

Geogr. Distribution.—Hungary.

The typical form of this species is not known to occur in the British Islands.

Var. **obtusius** Gutw. (Pl. LXXI, fig. 40.)

C. Sinostegos Schaarschm. var. *obtusius* Gutw. in Nuova Notarisia, III, 1892, p. 21; Flor. Glonów Galic. 1892, p. 131, t. 3, f. 13; West & G. S. West, Alg. Madag. 1895, p. 58, t. 6, f. 33; Some N. Amer. Desm. 1896, p. 247; Nordst. Index Desm. 1896, p. 234; West & G. S. West, Welw. Afric. Freshw. Alg. 1897, p. 118; Alg. S. England, 1897, p. 487.

Cells about $1\frac{1}{6}$ times as broad as long, lower angles less acuminate, apex sometimes slightly depressed; vertical view elliptic with acute poles.

Length 9–14 μ; breadth 10·5–17 μ; breadth of isthmus 1·8–3·6 μ; thickness 5·5–9 μ.

England.—Puttenham Common, Surrey!

Ireland.—Near Glenties, Loughs Anna and Nacally, Donegal! Lough Derryadd, Armagh!

Geogr. Distribution.—Silesia in Austria. United States. Madagascar.

The typical form of *C. Sinostegos* does not appear to have been observed since its original discovery by Schaarschmidt, but Gutwinski's var. *obtusius* has a wide geographical distribution. It differs principally in the lower angles of the semicells being much less produced. It should be compared with *C. polygonum*, *C. geometricum*, and *C. adoxum*.

The form of *C. Sinostegos* described and figured by Johnson ('Rare Desm. U. S.,' II, 1895, p. 294, t. 240, f. 29) must be referred to var. *obtusius*.

101. **Cosmarium abruptum** Lund.

(Pl. LXXII, figs. 1, 2.)

Cosmarium abruptum Lund. Desm. Suec. 1871, p. 43, t. 2, f. 22; De Toni, Syll. Alg. 1889, p. 947; Roy & Biss. Scott. Desm. 1894, p. 41; Nordst. Index Desm. 1896, p. 36; West & G. S. West, Alg. S. England, 1897, p. 489; Alga-fl. Yorks. 1900, p. 92.

Ursinella abrupta Kuntze, Revis. gen. plant. 1891, p. 894.

Cells minute, a little longer than broad, deeply constricted, sinus narrow and linear; semicells transversely subrectangular, apex produced and truncate, sides slightly retuse, both inferior and superior angles very minutely truncate, on each side between the superior angles and the apex narrowly retuse. Side view of semicell subcircular, with a median papilla on each side. Vertical view elliptic, with a papilla at the middle on each side, ratio of axes (without papilla) 1 : 1·7. Cell-wall smooth. Chloroplast axile with a central pyrenoid.

Zygospore unknown.

Length 18–20 μ; breadth 15·5–18 μ; breadth of isthmus 4·5–5·5 μ; thickness 12 μ.

England.—Mickle Fell, N. Yorks! Leicestershire (*Roy*). Enbridge Lake, Hants (*Roy*). Halgavor Moor, Cornwall!

Scotland.—Nairn; Howford, Alford, Birsemore

Loch, Bogwartle, Aberdeen; Dalbrake, Kincardine; Menmuir and Barrelwell near Brechin, Forfar (*Roy & Bissett*). Hoy, Orkneys!

Geogr. Distribution.—France. Galicia in Austria (form). Italy. Norway. Sweden. Denmark. Bornholm. Poland. N. Russia. Afghanistan. India. Madagascar (var.). Central Africa (var.). E. Africa (var.). Australia (var.). United States.

C. abruptum should be compared with *C. Blyttii*, the Desmid to which it is very probably most nearly related. The existence of *C. abruptum* var. *granulatum* W. & G. S. West ('Alg. Madag.' 1895, p. 65, t. 7, f. 32), with a wide geographical distribution, emphasizes the closeness of this relationship.

102. **Cosmarium sexangulare** Lund.

(Pl. LXXII, fig. 3.)

Cosmarium sexangulare Lund. Desm. Suec. 1871, p. 35, t. 2, f. 23; Delp. Desm. subalp. 1877, p. 15, t. 7, f. 69–73 [figures not typical]; Wolle, Desm. U. S. 1884, p. 63, t. 16, f. 8, 9 [figures not good]; De Toni, Syll. Alg. 1889, p. 954; Roy & Biss. Scott. Desm. 1894, p. 174; Nordst. Index Desm. 1896, p. 233.

Ursinella sexangularis Kuntze, Revis. gen. plant. 1891, p. 925.

Cells of moderate size, about $1\frac{1}{5}$ times longer than broad, deeply constricted, sinus very narrow, with a dilated apex; semicells transversely elliptic-hexagonal, angles rounded, upper lateral margins very slightly concave, apex truncate and straight. Side view of semicell subcircular. Vertical view elliptic, ratio of axes 1 : 1·5. Cell-wall very finely punctate. Chloroplasts one in each semicell, axile, with one pyrenoid.

Zygospore unknown.

Length 42 μ; breadth 34–36 μ; breadth of isthmus 11–12 μ; thickness 22–24·5 μ; breadth of apex 15–18 μ.

Scotland.—Loch Hempriggs, Caithness; Scotston Moor, Brimmond, Slewdrum, near Aboyne, and Pittellachie in Cromar, Aberdeen; Crathes, Loch Loirston, and Paldy Hill, Kincardine (*Roy & Bissett*).

Geogr. Distribution.—Germany. Galicia in Austria. Hungary. Sweden. Poland. N. and S. Russia.

Japan. Australia. E. Africa. Azores (form). United States.

C. abbreviatum Racib. is closely allied to *C. sexangulare*, but is smaller and of different proportions.

Forma **minima** Nordst. (Pl. LXXII, figs. 4, 5.)

C. sexangulare Lund. forma *minima* Nordst. in Botan. Notis. 1887, p. 162; Freshw. Alg. N. Zeal. 1888, p. 60, t. 7, f. 26, 27; Gutw. Flor. Glon. Okolic Lwowa, 1891, p. 46; Borge, Süssw. Chlor. Archang. 1894, p. 28, t. 2, f. 29; Gutw. Flor. Glon. Okolic Tarnapola, 1894, p. 87; Nordst. Index Desm. 1896, p. 233; G. S. West, Alg. Third Tanganyika Expedit. 1907, p. 119.

About one third the size of the typical form, semicells with the apex retuse and the upper lateral margins conspicuously retuse.

Length 13·5–15 μ; breadth 11–12 μ; breadth of apices 5–8 μ; breadth of isthmus 3 μ.

Scotland.—Near Finstown, Orkneys!

Geogr. Distribution. — Russia. Poland. Central Africa. Australia. New Zealand. Argentina.

This form differs mostly in its minute size. The width of the apex is very variable, and the superior lateral margins are undoubtedly more retuse than in the typical form. It should be compared with some of the small forms of *C. Regnellii*.

The Desmid figured by Borge ('Alg. Argentina u. Boliv.' 1906, p. 7, f. 2) as "*C. granatum* var. *subangulare* West forma minor apicibus semicellularum latioribus" is without doubt referable to *C. sexangulare* forma *minima*. On the other hand, Bohlin ('Flor. Algol. d'eau douce d. Açores,' 1901, p. 70, t. 1, f. 32) records and figures a form of *C. granatum* Bréb. under the name of *C. sexangulare* f. *minima*.

103. **Cosmarium pseudoprotuberans** Kirchn. (Pl. LXXII, figs. 6–8.)

Cosmarium bioculatum Bréb. forma Nordst. Desm. Spets. 1872, p. 29.
C. pseudoprotuberans Kirchn. Alg. Schles. 1878, p. 150; Nordst. Desm. Grönland, 1885, p. 8, t. 7, f. 3; De Toni, Syll. Alg. 1889, p. 951; ? Turn. Freshw. Alg. E. India, 1893, p. 59, t. 10, f. 6; ? Börg. Ferskv. Alg. Östgrönl. 1894, p. 18, t. 1, f. 12; Roy & Biss. Scott. Desm. 1894, p. 172; Johnson, Rare Desm. U. S. II, 1895, p. 293, t. 240, f. 24; Schmidle, Beitr. alp. Alg. 1895, p. 389; Nordst. Index Desm. 1896, p. 210; West & G. S. West, New and Int. Freshw. Alg. 1896, p. 155, t. 4, f. 34; Alg. S. England, 1897, p. 486.
C. pseudoprotuberans a. *Kirchneri* Racib. Nonn. Desm. Polon. 1885, p. 82.
Ursinella pseudoprotuberans Kuntze, Revis. gen. plant. 1891, p. 925.

Cells rather small, a little longer than broad, deeply constricted, sinus open and obtuse, with subparallel sides; semicells transversely subelliptic or subhexagonal-elliptic, lateral angles obtuse, lower lateral margins rather longer than upper lateral margins, slightly convex, apex widely truncate-convex. Side view of semicell subcircular. Vertical view subrhomboid-elliptic, ratio of axes about 1 : 1·5. Cell-wall very delicately punctate (often appearing smooth). Chloroplasts axile, one in each semicell, with a central pyrenoid.

Zygospore globose and smooth.

Length 20–41 μ; breadth 18–36 μ; breadth of isthmus 8–10·5 μ; thickness 11–17 μ; diam. zygosp. (of small form) 30 μ.

England.—Bowness, Westmoreland! Epping Forest, Essex! Thursley Common, Surrey (with zygospores)! New Forest, Hants!

Scotland.—Loch Ruthven and Clachan, Inverness (*Roy & Bissett*).

Geogr. Distribution.—Germany. Galicia in Austria. Norway. Sweden. Poland. Russian Lapland. Greenland (var.). India. New Zealand (var.). Australia (var.). Madagascar (var.). Central and East Africa. United States.

C. pseudoprotuberans exhibits considerable variation in size. It is distinguished from *C. sexangulare* by its less deep and more open sinus, and by the more rounded character of its apices.

Nordstedt has described a trigonal variety (*β trigonum*) from Greenland (*vide* Nordst. 'Desm. Grönland,' 1885, p. 7, t. 7, f. 2); length 29 μ; breadth 26–28 μ.

Var. **alpinum** Racib. (Pl. XCI, fig. 10.)

C. pseudoprotuberans Kirchn. c. *alpinum* Racib. Nonn. Desm. Polon. 1885, p. 83, t. 10, f. 11; Roy & Biss. Scott. Desm. 1894, p. 172.

Cells much smaller; semicells with the superior lateral margins forming part of the apex, which is relatively very wide; sinus somewhat narrower.

Length 10·5–12·5 μ; breadth at apex of semicells 10·5–12·5 μ; breadth of isthmus 6·5 μ; thickness 7·5–8·5 μ.

Scotland.—Small pool on the north side of Loch Dawin, Cromar, Aberdeen (*Roy & Bissett*).

Geogr. Distribution.—Poland. Galicia in Austria.

104. **Cosmarium abbreviatum** Racib.

(Pl. LXXII, figs. 9–11.)

Cosmarium abbreviatum Racib. Nonn. Desm. Polon. 1885, p. 83, t. 10, f. 13; De Toni, Syll. Alg. 1889, p. 950; Schmidle, Chlorophy.-Fl. Torfstiche Virnheim, 1894, p. 56; Roy & Biss. Scott. Desm. 1894, p. 40; Nordst. Index Desm. 1896, p. 36; West & G. S. West, Alg. S. England, 1897, p. 486; G. S. West, Alga-fl. Cambr. 1899, p. 216; West & G. S. West, Alga-fl. Yorks. 1900, p. 92; Alg. N. Ireland, 1902, p. 34; Notes Alg. III, 1903, p. 10 (sep.); Scott. Freshw. Plankton, I, 1903, p. 526; Freshw. Alg. Orkneys and Shetlands, 1905, p. 22; Further Contrib. Freshw. Plankton Scott. Lochs, 1905, p. 484.

Ursinella abbreviata Kuntze, Revis. gen. plant. 1891, p. 924.

Cells small, about as long as broad or a little broader, deeply constricted, sinus narrowly linear with a slightly dilated apex; semicells transversely elongate-hexagonal, angles slightly rounded, apex broadly truncate, straight or slightly retuse. Side view of semicell subcircular. Vertical view narrowly elliptic, ratio of axes about 1 : 2·1. Cell-wall smooth. Chloroplasts axile, with a central pyrenoid.

Zygospore unknown.

Length 12·5–22 μ; breadth 13–22 μ; breadth of isthmus 2–7 μ; thickness 7·2–9·5 μ.

England.—Brothers' Water, Westmoreland! Hampsfell, Lancashire! Pilmoor, N. Yorks! Skipwith Common, E. Yorks! Epping Forest, Essex! Ely, and between March and Guyhirne, Cambridge! Uxbridge, Middlesex! Enbridge Lake, Hants. (*Roy*). Near Crowan, Cornwall!

Wales.—Llyn-y-cwm-ffynon, Llyn Ogwen, and Capel Curig, Carnarvonshire!

Scotland.—Loch Kinellan, Ross; Brin, Inverness; Nairn; Scotston, Birsemore, Heugh-head, Milton Moor, Culblean, and Lochnagar, Aberdeen; Nigg, Cammie,

Kerloch, and Dalbrake, Kincardine; Clova Table-land, Forfar; Moncreiffe Hill, Perth (*Roy & Bissett*). Loch Tay, Perth! Rhiconich, Sutherland! Orkneys! Not uncommon in the plankton, Shetlands!

Ireland.—Gortahork, Loughs Cloncarney, Darragh, Garten, and Sproule, Donegal! Lough Derryadd, Armagh!

Geogr. Distribution.—Germany. Galicia in Austria. Poland. Australia.

C. abbreviatum should be compared with *C. sexangulare* and with *C. pseudobireme*.

Forma **minor** West & G. S. West. (Pl. LXXII, fig. 12.)

C. abbreviatum Racib. forma *minor* West & G. S. West, Alga-fl. Yorks. 1900, p. 92.

About half the size of the type.

Length 8 μ; breadth 9 μ.

England.—Skipwith Common, E. Yorks!

Var. **planctonicum** W. & G. S. West. (Pl. LXXII, fig. 13.)

C. abbreviatum Racib. var. W. & G. S. West, Scott. Freshw. Plankton, I, 1903, p. 541, t. 15, f. 6.

C. abbreviatum Racib. var. *planctonicum* W. & G. S. West, Further Contrib. Plankton Scott. Lochs, 1905, p. 500; Comp. Study Plankton Irish Lakes, 1906, p. 85.

Semicells with the superior angles more rounded.

Length 19–29 μ; breadth 22–30 μ; breadth of isthmus 5·5–8 μ; thickness 10·5–13·5 μ.

England.—Plankton of Buttermere and Crummock Water, Cumberland! Plankton of Red Tarn, Helvellyn, Westmoreland!

Wales.—Plankton of Llyn Cwlyd, Llyn Elsie, Cwellyn, and Llyn Ogwen, Carnarvonshire!

Scotland.—Plankton of Lochs of Ross, Inverness, and Perth; and of Lewis, Outer Hebrides!

Ireland.—Plankton of Loughs in Mayo, Galway, and Kerry!

This variety retains its characters very constantly, and we

have only observed it from the plankton. It sometimes exceeds the dimensions of the typical form, and often occurs abundantly in the plankton of the British lakes.

105. **Cosmarium impressulum** Elfv. (Pl. LXXII, figs. 14–18.)

Cosmarium Meneghinii Bréb. forma Reinsch, Contrib. Alg. et Fung. 1875, t. 12, f. 12 *a*, *b*.

C. Meneghinii Bréb. *β simplicissimum* Wille, Norges Ferskv. Alg. 1880, p. 30, t. 1, f. 11 a^1 [not fig. 11 *a*]; Nordst, Freshw. Alg. N. Zeal. 1888, p. 58; De Toni, Syll. Alg. 1889, p. 938; West, Desm. Maine, 1888, p. 339; Alg. N. Wales, 1890, p. 289; Gutw. Flor. glonów Galic. 1892, p. 125; West & G. S. West, Welw. Afric. Freshw. Alg. 1897, p. 37; Schmidt, Grundl. Algenfl. Lüneburg. Heide, 1903, p. 35.

C. impressulum Elfv. Anteck. Finska Desm. 1881, p. 13, t. 1, f. 9; Roy & Biss. Jap. Desm. 1886, p. 195, t. 268, f. 10; Hansg. Prodr. Algenfl. Böhm. 1888, p. 248; De Toni, Syll. Alg. 1889, p. 840; Heimerl, Desm. alp. 1891, p. 599; West, Alg. W. Ireland, 1892, p. 147; Alg. Engl. Lake Distr. 1892, p. 726; Roy & Biss. Scott. Desm. 1894, p. 104; Johnson, Rare Desm. U. S. I, 1894, t. 211, f. 6; Schmidle, Beitr. alp. Alg. 1895, p. 388; Nordst. Index Desm. 1896, p. 143; West & G. S. West, Alg. S. England, 1897, p. 487; G. S. West, Alga-fl. Cambr. 1899, p. 216; West & G. S. West, Alga-fl. Yorks. 1900, p. 92; Alg. N. Ireland, 1902, p. 35; G. S. West, W. Indian Freshw. Alg. 1904, p. 285; West & G. S. West, Further Contrib. Freshw. Plankton Scott. Lochs, 1905, p. 484.

Euastrum (*Cosmarium*) *impressulum* Gay, Monogr. loc. Conj. 1884, p. 61.

Cosmarium Meneghinii Bréb. forma *Reinschii* Istvanffi, Diag. præv. Alg. nov. Hungar. 1887, p. 237; Gutw. Flor. glonów Galic. II, 1890, p. 12; Borge, Bidr. Siber. Chlor. 1891, p. 12, t. 1, f. 8; Gutw. Flor. glonów Galic. III, 1892, p. 125; Borge, Süssw. Chlor. Archang. 1894, p. 27, t. 2, f. 26; Börg. Ferskv. Alg. Östgrönl. 1894, p. 16; Borge, Austral. Süsswasserchlor. 1896, p. 24; Trop. u. subtrop. Süssw.-Chlor. 1899, p. 22; Süsswasseralgen Süd-Patagon. 1901, p. 25; Bohlin, Flor. Algol. d'eau douce d. Açores, 1901, p. 69; Börg. Freshw. Alg. Færöes, 1901, p. 224; Borge, Alg. erst. Regnell. Exped., II. Desmid. 1903, p. 98; Alg. Argentina u. Boliv. 1906, p. 7.

Ursinella impressula Kuntze, Revis. gen. plant. 1891, p. 925.

Cosmarium crenulatum (Ehrenb.) Bréb. var. *Reinschii* Schmidle, Beitr. Algenfl. Schwarzwald. u. Rheineb. 1893, p. 96, t. 4, f. 10; Schröder, Alg. Versuchsteiche Schles. Fischereiv. Trachenberg. 1897, p. 27.

C. subortogonum Racib. "forma minor crenis minoribus" Borge, Algologische Notizen, 5 (in 'Bot. Notis.') 1900, p. 4 (sep.), cum fig. 2.

C. Meneghinii formæ Hirn, Desm. Finland, 1903, t. 1, f. 6 (?) et 7.

Cells rather small, about $1\frac{1}{2}$ times as long as broad, deeply constricted, sinus narrowly linear with a slightly dilated apex; semicells semi-elliptic or subsemicircular, margin regularly and markedly 8-undulate (sometimes almost crenate); crenations (including basal angles) equal, two at the apex and two on each of the convex sides. Side view of semicell broadly elliptic or elliptic-subcircular. Vertical view elliptic, ratio of axes about

1 : 1·6. Cell-wall smooth. Chloroplasts axile, with a central pyrenoid.

Zygospore unknown.

Length 24–36 μ; breadth 19–26 μ; breadth of isthmus 5–9 μ; thickness 10–14 μ.

England.—Westmoreland! Lancashire! W., N., and E. Yorks! Essex! Cambridge! Middlesex! Surrey! Hants! (*Roy*). Devon! Cornwall!

Wales.—Llyn Idwal, Carnarvonshire!

Scotland.—General, but scarce! (*Roy & Bissett*). Common in Sutherland and the Outer Hebrides!

Ireland.—Donegal! Galway! Kerry! Londonderry! Ram's Island, Lough Neagh!

Geogr. Distribution.—France. Germany. Switzerland. Bohemia and Galicia in Austria. Denmark. Finland. Faeroes. Greenland. Bosnia. Siberia. Japan. India. New Zealand. Australia. W. and E. Africa. Azores. United States. Brazil. Argentina. Patagonia.

This species has been largely confused with *C. Meneghinii* Bréb., with which it is connected by certain intermediate forms. In its typical condition, which is also its commonest state, it is very distinct, and the form of the semicells at once distinguishes it from Brébisson's species. Moreover, it retains its characters so constantly in all parts of the world, and is so widely distributed, that there are no preponderating reasons why it should be regarded as a variety of *C. Meneghinii*. The eight equal and pronounced undulations at the margin of each semicell render *C. impressulum* easy of recognition. The hollow between the two apical undulations is often less deep than the remaining hollows, giving the appearance of a decided apical region of the semicell.

C. impressulum should be compared with *C. undulatum*, from which it differs in its general proportions, in the form of its semicells, and in the fewer marginal undulations.

Borge ('Süssw. Chlor. Archang.' 1894, p. 27, t. 2, f. 27) has described a Desmid from N. Russia as *C. subimpressulum*. We have also recorded the same form from the United States (consult West & G. S. West, 'Some N. Amer. Desm.' 1896, p. 247, t. 15, f. 18). It appears to differ from *C. impressulum* in the rectangular basal part of the semicells, in the more crenate sides, in the prominent apex, and in the broad inflation on each side of the vertical view.

Another Desmid described by Raciborski ('Desm. Nowe,' 1889, p. 85, t. 5, f. 29), as *C. suborthogonum*, only differs from *C. impressulum* in the presence of a slight protuberance in the middle of each side of the vertical view, and this form would in consequence be best placed as *C. impressulum* forma *suborthogona*.

106. **Cosmarium umbilicatum** Lütkem.

(Pl. LXXII, figs. 19–21.)

Cosmarium umbilicatum Lütkem. Desm. Attersees, 1893, p. 550, t. 8, f. 2; Nordst. Index Desm. 1896, p. 265; West & G. S. West, Alg. S. England, 1897, p. 487; Alga-fl. Yorks. 1900, p. 92.

Cells small, a little longer than broad, deeply constricted, sinus very narrow with a dilated apex; semicells angularly subsemicircular, sides triundulate, lower parts of sides upwardly diverging or rarely subparallel, upper parts strongly converging, upper and lower angles slightly rounded, apex truncate and straight, with a uniscrobiculate tumour in the centre of each semicell. Side view of semicell subcircular. Vertical view elliptic, with a slight protuberance at the middle on each side. Cell-wall finely punctate.

Zygospore unknown.

Length 18–20 μ; breadth 15·5–17 μ; breadth of isthmus 5–5·5 μ; thickness 10·5 μ.

England.—Malton, N. Yorks! Brent Reservoir, Middlesex!

Geogr. Distribution.—Austria.

This small species stands nearest to *C. impressulum* forma *suborthogona* and *C. perpusillum*.

107. **Cosmarium perpusillum** West.

(Pl. LXXII, figs. 22, 23.)

Cosmarium perpusillum West, Alg. W. Ireland, 1892, p. 148, t. 21, f. 2; Nordst. Index Desm. 1896, p. 199.

Cells minute, a little longer than broad, very deeply constricted, sinus narrowly linear with a dilated apex; semicells subhexagonal, angles very slightly rounded, lower lateral margins slightly retuse, upper lateral

margins with one median undulation (one crest and two hollows), apex broadly truncate or very slightly retuse. Side view of semicell broadly elliptic-ovate. Vertical view elliptic, ratio of axes about 1 : 1·9. Cell-wall smooth. Chloroplasts axile, one in each semicell, containing a central pyrenoid.

Zygospore unknown.

Length 10·6–11 μ; breadth 9·5–9·8 μ; breadth of isthmus 1·4–2·5 μ; thickness 5 μ.

Ireland.—Ballynahinch, Galway!

This small species stands near to the small *Cosmarium* described by Wille as "*C. Meneghinii* var. *nanum*," but differs in its smaller size, its much deeper constriction, and in the character of its cell-outlines. From *C. umbilicatum* Lütkem. it is distinguished by its much smaller size, its deeper constriction, and the absence of the scrobiculated central protuberance. The form of its semicells, its small size, and deep constriction are sufficient to readily distinguish it from *C. Meneghinii*.

In Hoy, Orkney Islands, among *Sphagnum*, a large form was observed in which the apex was somewhat more retuse and not quite so wide: length 16 μ; breadth 14 μ (Pl. LXXII, fig. 24).

108. **Cosmarium Regnellii** Wille.

(Pl. LXXII, figs. 25–28.)

Cosmarium Regnellii Wille, Sydamerik. Algfl. 1884, p. 16, t. 1, f. 34; De Toni, Syll. Alg. 1889, p. 939; Turn. Freshw. Alg. E. India, 1893, p. 49, t. 7, f. 25, 26; Borge, Süssw. Chlor. Archang. 1894, p. 28; West & G. S. West, Some N. Amer. Desm. 1896, p. 248, t. 15, f. 20; Nordst. Index Desm. 1896, p. 222; West & G. S. West, Alg. S. England, 1897, p. 487; G. S. West, Alga-fl. Cambr. 1899, p. 216; West & G. S. West, Alga-fl. Yorks. 1900, p. 93; Alg. N. Ireland, 1902, p. 35; Freshw. Alg. Orkneys and Shetlands, 1905, p. 22.

Ursinella Regnellii Kuntze, Revis. gen. plant. 1891, p. 925.

Cells rather small, about as long as broad, deeply constricted, sinus very narrowly linear with a slightly dilated apex; semicells trapezoid-hexagonal, lower lateral margins longer than the upper lateral margins and slightly retuse, upper lateral margins markedly retuse, lateral angles projecting and rounded, slightly upwardly divergent, apex broadly truncate. Side view of semicell rounded-ovate. Vertical view sub-

oblong-elliptic, ratio of axes about 1 : 2·4. Cell-wall smooth. Chloroplasts axile, one in each semicell, with a central pyrenoid.

Zygospore unknown.

Length 14–22 μ; breadth 15–22 μ; breadth of isthmus 4–7 μ; thickness 6·5–11 μ.

England.—Angle Tarn, Cumberland! Pilmoor, N. Yorks! Epping Forest, Essex! Twenty-foot River between March and Guyhirne, Cambridge! Harefield, Middlesex! Bisley Common, Surrey! Slapton Sands, Devonshire! Near The Lizard, Cornwall!

Scotland.—Orkneys! Shetlands!

Ireland.—Dungloe and Lough Connell, Donegal! Near Recess, Galway!

Geogr. Distribution.—Germany. Galicia in Austria. Norway (form). Sweden. Finland. N. Russia. Faeroes. Greenland. Siberia (form). India. Ceylon. Madagascar (var.). Azores (form). United States. Brazil. Bolivia. Uruguay. Patagonia.

C. Regnellii is nearly related to *C. Meneghinii*, but is easily distinguished by its prominent lateral angles and broad, straight apices. The lower parts of the sides of the semicells are outwardly divergent in *C. Regnellii*, whereas the basal angles of *C. Meneghinii* are rectangular.

A small form was abundant from Hawkshead, Lancashire, in which the semicells were more regularly hexagonal and the sinus was not so completely closed: length 11–12 μ; breadth 11–14 μ; breadth of isthmus 3·5–4 μ; thickness 6 μ (*vide* West, 'Alg. Engl. Lake Distr.' 1892, p. 725, t. 9, f. 20).

Certain forms were observed from Twenty-foot River, between March and Guyhirne, Cambs., which approached *C. Regnellii* var. *madagascariense* W. & G. S. West ('Alg. Madag.' 1895, p. 58, t. 6, f. 39), but were proportionately longer with a very narrow isthmus; length 16 μ; breadth 14·5 μ; breadth of isthmus 3 μ.

109. **Cosmarium Meneghinii** Bréb.

(Pl. LXXII, figs. 29–32.)

Cosmarium Meneghinii Bréb. in Ralfs' Brit. Desm. 1848, p. 96, t. 15, f. 6 [*Cosmarium biocu'atum* Menegh. 1837]: Rabenh. Flor. Europ. Alg. III, 1868, p. 163; ? Reinsch, Contrib. Alg. et Fung. 1875, t. 16, f. 5; Boldt,

Siber. Chlorophy. 1885, p. 103; Cooke, Brit. Desm. 1886, p. 93, t. 37, f. 11; Hansg. Prodr. Algenfl. Böhm. 1888, p. 194; De Toni, Syll. Alg. 1889, p. 937; West, Alg. N. Yorks. 1889, p. 292; Alg. N. Wales, 1890, p. 289; Heimerl, Desm. alp. 1891, p. 599; West, Alg. W. Ireland, 1892, p. 148; Alg. Engl. Lake Distr. 1892, p. 726, t. 9, f. 14; Lütkem. Desm. Attersees, 1893, p. 550; Roy & Biss. Scott. Desm. 1894, p. 168; Nordst. Index Desm. 1896, p. 167; West & G. S. West, Alg. S. England, 1897, p. 487; Welw. Afric. Freshw. Alg. 1897, p. 119; Schmidle, Lappmark Süsswasseralgen, 1898, p. 27; G. S. West, Alga-fl. Cambr. 1899, p. 216; Lütkem. Desm. Millstättersees, 1900, p. 9; West & G. S. West, Alga-fl. Yorks. 1900, p. 93; Borge, Süsswasseralgen Süd-Patagon. 1901, p. 25; West & G. S. West, Alg. N. Ireland, 1902, p. 35; Freshw. Alg. Ceylon, 1902, p. 166; Borge, Alg. erst. Regnell. Exped., II. Desmid. 1903, p. 98; Larsen, Freshw. Alg. E. Greenland, 1904, p. 86; West & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 22; Borge, Alg. Argentina u. Boliv. 1906, p. 7.

Didymidium (*Cosmarium*) *Braunii* Reinsch, Algenfl. Frank. 1867, p. 115, t. 10, f. 3 [in part; *a* ? and *d* (="Aγ *Meneghinii*" Reinsch, l. c. p. 115)].

Cosmarium Meneghinii forma *vulgaris* Jacobs. Desm. Danem. 1876, p. 197; Anderss. Sverig. Chlor. 1890, p. 16; Börg. Freshw. Alg. Færoës, 1901, p. 224.

C. Meneghinii a. *genuinum* Kirchn. Alg. Schles. 1878, p. 148; Hansg. Prodr. Algenfl. Böhm. 1888, p. 195; Gutw. Flor. glonów Galic. II, 1890, p. 11; Flor. Glon. Okolic Tarnapola, 1894, p. 85.

Euastrum (*Cosmarium*) *Meneghinii* (Bréb.) Gay, Monogr. loc. Conj. 1884, p. 58.

Ursinella Meneghinii Kuntze, Revis. gen. plant. 1891, p. 925.

Cells small, suboctangular, almost $1\frac{1}{2}$ times as long as broad, deeply constricted, sinus narrow and linear; semicells transversely rectangular in the lower part and pyramidate-truncate in the upper part, lower parts of sides parallel and slightly retuse, upper parts of sides strongly convergent and retuse, apex widely retuse, all the angles somewhat rounded. Side view of semicell broadly elliptic or subcircular. Vertical view elliptic, ratio of axes about 1 : 1·5. Cell-wall smooth. Chloroplasts axile, one in each semicell, with a central pyrenoid.

Zygospore globose, furnished with short acute or subacute spines (often slightly curved), from 11–18 of which show at the periphery.

Length 12·5–24 μ; breadth 9·5–17 μ; breadth of isthmus 3–6 μ; thickness 6–10·5 μ; diam. zygosp. without spines 18–26 μ; with spines 30–37 μ.

England. — Cumberland! Westmoreland! Lancashire! W., N., and E. Yorks! Cheshire (*Roy*). Leicestershire (*Roy*). Lincolnshire! Essex! Cam-

bridgeshire! Middlesex! Surrey! Sussex! Kent! Hants! Gloucestershire! Devon! Cornwall! (*Marquand*).

Wales.—General, but never abundant!

Scotland.—Abundant! (*Roy & Bissett*). We find it general but certainly not abundant.

Ireland.—General!

Geogr. Distribution.—France. Germany. Austria (and Galicia). Hungary. Italy. Norway. Sweden. Denmark. Bornholm. Finland. Poland. Lapland. N., Central, and S. Russia. Faeroes. Iceland. Nova Zembla. Greenland. Siberia. Mongolia. China. Central China (form). Japan. India. Ceylon. Siam. Chatham Island. New Zealand. Madagascar. Central Africa. Azores. United States. Porto Rico. Jamaica. Brazil. Ecuador. Paraguay. Argentina. Patagonia.

C. Meneghinii is a very widely distributed species, occurring more or less abundantly in all parts of the world. In its typical form, which was well figured by Ralfs, it is very characteristic, but variations from this type are not uncommon, and intermediate forms are sometimes observed between it and *C. venustum*, *C. impressulum*, or *C. læve*. Probably no species has been more overburdened with named varieties and forms than *C. Meneghinii*. Most of these "varieties," however, have during recent years been shown to belong elsewhere. In the present work we have only retained one form (f. *latiuscula*) and one variety (var. *nanum*), and we are even inclined to think that the latter would be best placed elsewhere.

C. Braunii (Reinsch) Wolle (=*Didymidium Braunii* Reinsch) was a name given by Reinsch to a species-group which included Brébisson's *C. Meneghinii* and a number of allied forms. Reinsch's name (1867) is not tenable; he should have retained the older name "*Meneghinii*" (1848).

We have transferred Wille's "forma *octangularis*" to *C. læve*, to which species it seems more rightly to belong.

Nordstedt has mentioned a trigonal form from Finshö, Norway (*vide* Nordst. 'Norges Desm.' 1873, p. 21).

Forma **latiuscula** Jacobs.

C. Meneghinii as figured by De Bary, Conj. 1858, p. 38 et seq., t. 6, f. 33–46.

C. Meneghinii forma *latiuscula* Jacobs. Desm. Danem. 1876, p. 197; Hoff in Nordst. Desm. Bornh. 1888, p. 197; Anderss. Sverig. Chlor. 1890, p. 16; Börg. Freshw. Alg. Færoës, 1901, p. 224.

Semicells with a slight undulation in the middle of the retuse upper parts of the sides. It has the appearance of a reduced *C. impressulum* in which the undulations are not nearly so prominent.

Length 20–23 μ; breadth 15–16·5 μ.

Widely distributed in the British Islands and in continental Europe.

Var. **nanum** Wille. (Pl. LXXII, fig. 34.)

C. Meneghinii var. *nanum* Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 43, t. 12, f. 35; West, Alg. W. Ireland, 1892, p. 149.

A small variety with elliptic-hexagonal semicells; lower parts of sides upwardly diverging, upper parts with a minute median undulation, apex truncate and straight.

Length 19 μ; breadth 15 μ; breadth of isthmus 6 μ; thickness 11 μ.

Ireland.—Cromagloun, Kerry!

Geogr. Distribution.—Nova Zembla.

The actual form of the semicell of this variety is nearer that of *C. perpusillum* than *C. Meneghinii*, but the depth of the constriction and the form of the vertical view are different.

110. **Cosmarium angulosum** Bréb.

(Pl. LXXII, figs. 35, 36.)

Cosmarium angulosum Bréb. Liste Desm. 1856, p. 127, t. 1, f. 17; Cooke, Brit. Desm. 1886, p. 93, t. 42, f. 18; Roy & Biss. Scott. Desm. 1894, p. 42; Nordst. Index Desmid. 1896, p. 45; G. S. West, Alga-fl. Cambr. 1899, p. 216; West & G. S. West, Alga-fl. Yorks. 1900, p. 93; Alg. N. Ireland, 1902, p. 35; G. S. West, Alg. Third Tanganyika Expedit. 1907, p. 119.

C. Meneghinii Bréb. var. *angulosum* (Bréb.) Rabenh. Flor. Europ. Alg. III, 1868, p. 163; Lund. Desm. Suec. 1871, p. 43; Kirchn. Alg. Schles. 1878, p. 148; Wille, Norges Ferskv. Alg. 1880, p. 30; Hansg. Prodr. Algenfl. Böhm. 1888, p. 195; De Toni, Syll. Alg. 1889, p. 938; Hoff in Nordst. Desm. Bornh. 1888, p. 198; West, Alg. N. Wales, 1890, p. 289; West & G. S. West, Welw. Afric. Freshw. Alg. 1897, p. 119; Börg. Freshw. Alg. Færoës, 1901, p. 224.

Cells small, about $1\frac{1}{2}$ times longer than broad (some-

times very little longer than broad), deeply constricted, sinus narrow and linear; semicells subquadrate or subrectangular, inferior angles scarcely rounded, sides straight and parallel, superior angles obliquely truncate, apex truncate and straight. Side view of semicell subcircular. Vertical view elliptic, ratio of axes about 1 : 1·7. Cell-wall smooth. Chloroplasts axile, one in each semicell, with a central pyrenoid.

Zygospore globose-octahedral, with eight subacute undulations round the margin.

Length 14·5–28 μ; breadth 13·5–18 μ; breadth of isthmus 3·2–6 μ; thickness 7·7–9·5 μ.

England.—Near Bowness, Westmoreland (*Bissett*). Pilmoor, N. Yorks! Skipwith Common, E. Yorks! Near Brigg, Lincolnshire! Dernford Fen and Wicken Fen, Cambridge! Enbridge Lake, Hants (*Roy*).

Wales.—Llyn Coron, Anglesey!

Scotland.—General! Zygospore from Blackhall, Kincardine (*Roy & Bissett*).

Ireland.—Gortahork, and Loughs Connell and Magrath, Donegal! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Bohemia and Galicia in Austria. Norway. Sweden. Denmark. Faeroes. Siam. Australia. United States. Central Africa.

C. angulosum is closely related to *C. Meneghinii*, but is distinguished from it by the straight sides and apex of the semicells, the truncate upper angles, and the greater angularity of the semicells. That these distinctions were justifiably regarded as specific in character received confirmation on the discovery of the zygospore by Messrs. Roy and Bissett. This zygospore differs much from that of *C. Meneghinii*, being furnished with a few rather low protuberances instead of spines.

Var. **concinnum** (Rabenh.) West & G. S. West. (Pl. LXXII, figs. 37, 38.)

Euastrum concinnum Rabenh. Alg. Europ. 1862, no. 1303 cum fig.
Cosmarium concinnum Reinsch Spec. Gen. Alg. 1867, p. 140, t. 22 B. I, f. 1–7 (formæ); Racib. Desmidyja Ciastonia, 1892, p. 371; Turn.

Freshw. Alg. E. India, 1893, p. 48, t. 7, f. 21; Roy & Biss. Scott. Desm. 1894, p. 44; West & G. S. West, Alg. Madag. 1895, p. 59, t. 9, f. 23; Nordst. Index Desm. 1896, p. 78; West & G. S. West, Alg. S. England, 1897, p. 487; Borge, Süsswasseralgen Süd-Patagon. 1901, p. 25.

Didymidium (*Cosmarium*) *concinnum* Reinsch, Algenfl. Frank. 1867, p. 110, t. 9, f. 3.

Cosmarium Meneghinii Bréb. var. *concinnum* Rabenh. Flor. Europ. Alg. III, 1868, p. 163; Wittr. Skandinav. Desm. 1869, p. 12; Kirchn. Alg. Schles. 1878, p. 148; Hansg. Prodr. Algenfl. Böhm. 1888, p. 195; De Toni, Syll. Alg. 1889, p. 938; Schmidle, Lappmark Süsswasseralgen, 1898, p. 27.

C. concinnum var. *læve* Wille, Norges Ferskv. Alg. 1880, p. 30, t. 1, f. 12; Lagerh. Bidrag Sver. Algfl. 1883, p. 54; Nordst. Freshw. Alg. N. Zeal. 1888, p. 58; West, Alg. W. Ireland, 1892, p. 149.

C. Meneghinii forma *lævis* Boldt in Bih. K. Sv. Vet.-Akad. Handl. xiii, 1888, p. 31.

C. angulosum var. *concinnum* (Rabenh.) West & G. S. West, Freshw. Chlorophy. Koh Chang, 1901, p. 91; Alg. N. Ireland, 1902, p. 35; Freshw. Alg. Orkneys and Shetlands, 1905, p. 22; G. S. West, Alg. Third Tanganyika Expedit. 1907, p. 119.

Cells a little smaller than in the type; upper angles of semicells obliquely truncate or retuse; sides of semicells sometimes very slightly concave.

Length 10·5–13 μ; breadth 8–12 μ; breadth of isthmus 2·6–4·5 μ; thickness 4·5–6·5 μ.

England.—Puttenham and Thursley Commons, Surrey! Enbridge Lake, Hants (*Roy*).

Wales.—Glyder Fawr and Snowdon, Carnarvonshire (*Roy*).

Scotland.—Sutherland! Ross, Inverness, Aberdeen, Kincardine, Forfar, Perth, and Argyll (*Roy & Bissett*). Outer Hebrides! Orkneys! Shetlands!

Ireland.—Several localities in Donegal! Near Foxford, Mayo! Derryclare Lough, Clifden, Ballynahinch, and Lakes E. of Lough Bofin, Galway! Adrigole, Kerry! Slieve Bearnagh, Down!

Geogr. Distribution.—France. Germany. Galicia in Austria. Norway. Sweden. Greenland. India. Australia. New Zealand. Madagascar. Central Africa. Uruguay. Argentina. Patagonia.

This variety can scarcely be separated from *C. angulosum*, as it differs only in its smaller size and the retuseness of the upper angles. The latter are, however, commonly truncate as in typical *C. angulosum*. In all forms the cell-wall is smooth with no trace of punctulations.

111. **Cosmarium difficile** Lütkem.

(Pl. LXXIII, figs. 1–3.)

Cosmarium difficile Lütkem. Desm. Attersees, 1893, p. 551, t. 8, f. 3; Nordst. Index Desm. 1896, p. 108; West & G. S. West, Alg. S. England, 1897, p. 487; Some Desm. U. S. 1898, p. 303; G. S. West, Alga-fl. Cambr. 1899, p. 217; West & G. S. West, Alga-fl. Yorks. 1900, p. 93; Alg. N. Ireland, 1902, p. 35; Scott. Freshw. Plankton, I, 1903, p. 526; Freshw. Alg. Orkneys and Shetlands, 1905, p. 22.

Cells small, about $1\frac{1}{2}$ times as long as broad, deeply constricted, sinus narrowly linear with a slightly dilated apex; semicells subrectangular with an elevated apex, basal angles rectangular and rounded, lower part of sides slightly retuse, upper part of sides retuse and converging towards the apex, which is convexly truncate with a minute median depression; with three transverse rows of minute scrobiculations across the semicells, one close to the base, one above the middle, and one just below the apex. Side view of semicell oblong-ovate. Vertical view elliptic-oblong, with a slight tumour at the middle on each side, and with a ring of about 8 minute (apical) scrobiculations surrounding about 4 central ones. Cell-wall very minutely and densely punctate. Chloroplasts axile, one in each semicell with a central pyrenoid.

Zygospore unknown.

Length 28–33 μ; breadth 20–22·5 μ; breadth of isthmus 4–6 μ; thickness 12·5–13 μ.

England.—Cumberland! Westmoreland! W., N., and E. Yorks! Essex! Cambridge! Surrey! Hants! Wilts! Devon! Cornwall!

Wales.—Llyn Bochlwyd, Llyn Gwynant, Y Foel Fras, Glyder Fawr, and Moel Siabod, Carnarvonshire! Merioneth! Radnor!

Scotland.—Rhiconich, Sutherland! Inverness! Ross! Forfar! Perth! Cumbræ! Common in the Outer Hebrides! Orkneys! Shetlands!

Ireland.—Donegal! Mayo! Galway! Kerry! Down (up to 2000 ft.)! Londonderry! Antrim!

Geogr. Distribution.—France. Germany. Austria. Poland. Italy. United States.

We had for some time regarded this Desmid as one of the forms of *C. Meneghinii*, and shortly after Lütkemüller's description of the species we expressed this opinion in the 'Journal of Botany,' xxxiii, 1895, p. 68. Since then, however, we have had reason to change this view. We find *C. difficile* to be very widely distributed and remarkably constant in its characters. It need never be confused with any form of *C. Meneghinii*. The semicells have a characteristic form, and the nature and disposition of the minute scrobiculations give a very distinctive feature to the species. It generally occurs in bogs, and most frequently among submerged *Sphagnum*, in which situations *C. Meneghinii* is very rarely found. Messrs. Roy and Bissett, and also Archer, must have observed this Desmid many times in their examination of Scottish and Irish Algæ, but doubtless included it in their conception of *C. Meneghinii*. Similarly, there is every reason to believe that the foreign distribution of *C. Meneghinii* includes many records of *C. difficile*.

The series of minute scrobiculations across the semicells are of a similar nature to those on the cell-wall of *C. zonatum* Lund. and *C. binerve* Lund.

Var. **sublæve** Lütkem. (Pl. LXXIII, figs. 4, 5.)

? *Cosmarium Meneghinii* Bréb. forma *rotundata* Jacobs. Desm. Danem. 1876, p. 198, t. 8, f. 20.

C. difficile var. *sublæve* Lütkem. Desm. Attersees, 1893, p. 552, t. 8, f. 4; West & G. S. West, Alg. S. England, 1897, p. 487; Schmidle, Lappmark Süsswasseralgen, 1898, p. 25; West & G. S. West, Alga-fl. Yorks. 1900, p. 93; Lütkem. Desm. Millstättersees, 1900, p. 8; West & G. S. West, Alg. N. Ireland, 1902, p. 35; Freshw. Alg. Orkneys and Shetlands, 1905, p. 22; Further Contrib. Freshw. Plankton Scott. Lochs, 1905, p. 484; Comp. Study Plankton Irish Lakes, 1906, p. 85.

Semicells with a slightly more convex base and a less prominently produced apex, upper (converging) parts of lateral margins not retuse; side view of semicell slightly thicker; scrobiculations more numerous in the three transverse series; cell-wall between the scrobiculations smooth.

Length 31–35 μ; breadth 20–22·5 μ; breadth of isthmus 5–6 μ; thickness 13–16 μ.

England. — Cumberland! Westmoreland! Lancashire! Wigton Moor, Cullingworth, Austwick Moss, and Cocket Moss, W. Yorks! Strensall and Pilmoor,

N. Yorks! Skipwith Common, E. Yorks! Surrey! Hants! Tintagel and Withiel, Cornwall!

Wales.—Glyder Fach (at 2200 ft.) and Llyn Geirionedd, Carnarvonshire!

Scotland.—Moidart, Inverness! Loch Cuthaig and Loch Fadaghoda, Lewis, Outer Hebrides! Orkneys! Shetlands!

Ireland.—Glenties, Loughs Anna and Machugh, Donegal! Plankton of the lakes in Kerry!

Geogr. Distribution.—Germany. Austria. Italy. N. Sweden. Australia.

This variety is almost as generally distributed as the typical form. It is distinguished by the form of its semicells and by the greater number of scrobiculations in the transverse rows.

112. **Cosmarium Clepsydra** Nordst.

(Pl. LXXIII, figs. 6, 7.)

Cosmarium Clepsydra Nordst. Desm. Brasil. 1870, p. 212, t. 3, f. 29; Lund. Desm. Suec. 1871, p. 37; De Toni, Syll. Alg. 1889, p. 1046; West, Alg. Engl. Lake Distr. 1892, p. 724, t. 9, f. 30 [figure not good]; Nordst. Index Desm. 1896, p. 74; Borge, Alg. erst. Regnell. Exped., II. Desmid. 1903, p. 102 [forma *major*].

C. Bicardia Reinsch, Contrib. Alg. et Fung. 1875, p. 83, t. 16, f. 15 [figure not good]; Nordst. Bornholm. Desm. 1888, p. 201; De Toni, Syll. Alg. 1889, p. 1007; Borge, Süssw. Chlor. Archang. 1894, p. 31, t. 3, f. 33; Roy & Biss. Scott. Desm. 1894, p. 42; Borge, Beiträge Alg. Schweden, 1906, p. 43, t. 3, f. 34 [forma].

Ursinella Clepsydra Kuntze, Revis. gen. plant. 1891, p. 924.

U. Bicardia Kuntze, l. c. p. 924.

Cells small, about as long as broad, subpolygonal, very deeply constricted, sinus narrowly linear with a slightly dilated apex; semicells somewhat angularly subsemicircular or broadly subtriangular, inferior angles obliquely bevelled to an obtuse angle, upper part of sides slightly convex or almost straight, apex obtusely pointed. Side view of semicell widely obcuneate, upper angles somewhat obliquely truncate, apex rounded-truncate. Vertical view rhomboidal with concave sides and obtuse angles, ratio of axes about 1 : 1·6. Cell-wall smooth. Chloroplasts one in each semicell, axile, with a central pyrenoid.

Zygospore unknown.

Length 18–21 μ; breadth 18–22 μ; breadth of isthmus 4·5–6·5 μ; thickness 11·5–16 μ.

England.—Near Bowness, Westmoreland!

Scotland.—Near Old Mill, Birsemore Loch, Craigendinnie Farm, Birkhill, and Bogwartle in Cromar, Cambus O'May, Dalbagie, and Ballochbirse, Aberdeen; Crathes, and Bishop's Dam, Kincardine (*Roy & Bissett*).

Geogr. Distribution.—Galicia in Austria. Bosnia. Sweden. Denmark. Finland. Poland. N. Russia. Japan. United States. Brazil. Paraguay (a form).

We think there is little doubt that *C. Clepsydra* Nordst. and *C. Bicardia* Reinsch are forms of the same species. Reinsch's figures are not very good, and that of the front view appears to be somewhat oblique. The slightly produced apices of Reinsch's figure are thus accounted for, as the large median inflations are near the apex of each semicell. The nearest relative of *C. Clepsydra* is *C. tithophorum* Nordst., a species which is fairly generally distributed in tropical and subtropical countries.

Another Desmid was described under the name of *Cosmarium Clepsydra* by Delponte in 1877 (*vide* 'Delp. Desm. subalp.' p. 8, t. 7, f. 35–36). This plant is regarded by Raciborski as a form of *C. integerrimum* (Näg.) Racib. ('Desm. Nowe' 1889, p. 79, t. 5, f. 35; = ? *Euastrum* (*Cosmarium*) *integerrimum* Näg. 'Gatt. einzell. Alg.' 1849, p. 119, t. 7, f. A 1).

113. **Cosmarium læve** Rabenh.

(Pl. LXXIII, figs. 8–19.)

Cosmarium læve Rabenh. Flor. Europ. Alg. III, 1868, p. 161; Nordst. Desm. Ital. 1876, p. 29, t. 12, f. 4; ? Wolle, Desm. U. S. 1884, p. 62, t. 15, f. 10; Cooke, Brit. Desm. 1886, p. 94; Hansg. Prodr. Algenfl. Böhm. 1888, p. 193; Borge, Süssw. Chlorophy. Archang. 1894, p. 26; Roy & Biss. Scott. Desm. 1894, p. 104; West & G. S. West, Alg. Madag. 1895, p. 59; Nordst. Index Desm. 1896, p. 153; West & G. S. West. Alg. S. England, 1897, p. 487; G. S. West, Variation Desm. 1897, p. 386, t. 10, f. 1–6; Schmidle, Lappmark Süsswasseralgen, 1898, p. 27; Ost-Afrika Desmid. 1898, p. 31; Lütkem. Desm. Millstättersees, 1900, p. 9; West & G. S. West, Alga-fl. Yorks. 1900, p. 94; Bohlin, Flor. Algol. d'eau douce d. Açores, 1901, p. 69; West & G. S. West, Freshw. Chlor. Koh Chang, 1901, p. 87, t. 2, f. 14; Borge, Süsswasseralgen Süd-Patagon. 1901, p. 24; Börg. Freshw. Alg. Færoës, 1901, p. 221; West & G. S. West, Alg. N. Ireland, p. 35; Freshw. Alg. Ceylon, 1902, p. 165; G. S.

West, W. Indian Freshw. Alg. 1904, p. 285; West & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 22; G. S. West, Alg. Third Tanganyika Expedit. 1907, p. 119.

C. Meneghinii Bréb. var. *simplicissimum* Wille, Norges Ferskv. Alg. 1880, t. 1, f. 11 *a*.

Euastrum (*Cosmarium*) *læve* Gay, Monogr. loc. Conj. 1884, p. 59.

Euastrum (*Cosmarium*) *leiodermum* Gay, l. c. p. 58, t. 1, f. 16.

Cosmarium Meneghinii Bréb. var. *subhexagonum* Hansg. Prodr. Algenfl. Böhm. 1888, p. 279.

C. leiodermum Hansg. l. c. 1888, p. 194, 247.

Ursinella lævis Kuntze, Revis. gen. plant. 1891, p. 925.

U. leioderma Kuntze, l. c. p. 925.

Cosmarium Gerstenbergii Richter, Phycotheca Univers. XIII, 1895, no. 635 cum fig. *a* et *b*; in Hedwigia, 1895, p. 23, fig. *a—c* (p. 24). [*Vide* Nordst. Index Desm. 1896, p. 153; et Schmidle, Beitr. Algenfl. Afrik. 1901, p. 66.]

Cells small, about $1\frac{1}{2}$ times as long as broad, very deeply constricted, sinus narrowly linear with a dilated apex; semicells semi-elliptic or semi-oblong-elliptic, with the basal angles slightly rounded or much rounded, apex narrowly truncate and retuse. Side view of semicell ovate-elliptic. Vertical view elliptic, ratio of axes about 1 : 1·5. Cell-wall delicately and often somewhat sparsely punctate or punctate-scrobiculate. Chloroplasts axile, one in each semicell, with a central pyrenoid.

Zygospore angular-globose, smooth, angles slightly thickened.

Length 15–34 μ; breadth 11·5–23 μ; breadth of isthmus 2·8–6·7 μ; thickness 9–13 μ; diam. of zygospore 22–25 μ.

England. — Westmoreland! W. and N. Yorks! Essex! Kent! Hants (*Roy*). Cornwall! (*Marquand*).

Wales.—Radnor!

Scotland.—Fouley, Aberdeen (*Roy & Bissett*). Glas Mhoel, Perth! Argyll! Cumbrae! Orkneys! Shetlands!

Ireland.—Errigal, Loughs Nacung and Sproule, Donegal! Slieve Donard, Down (at 2000 ft.)! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Galicia in Austria. Hungary. Italy. Spain. Portugal. Norway. Poland. N. Russia. Faeroes. Nova Zembla. India. Ceylon. Burma. Siam. Australia.

Madagascar. Central and E. Africa. Azores. United States. W. Indies. Ecuador. Uruguay. Argentina. Patagonia.

C. læve is a species with a wide distribution and a varied habitat. It does not frequent *Sphagnum*-areas, but thrives in small pools, ponds, ditches, and on dripping rocks. It may sometimes be obtained in great abundance with scarcely any intermixture of other Algæ. We have examined two such pure collections, one from the north of France and one from Hanka Deela, Somaliland. The form of the semicells is somewhat variable, especially with regard to the roundness of the basal angles and their general inflation. The slight retuseness in the middle of the apex is characteristic of all forms of the species.

The zygospores occurred abundantly on rocks in a river-bed in Koh Chang in the Gulf of Siam (consult W. & G. S. West, 'Freshw. Chlor. Koh Chang,' 1901, p. 87, t. 2, f. 14). We had previously attributed a spiny zygospore to this species, but we now know this to be an error (consult W. & G. S. West, 'New and Int. Freshw. Alg.' 1896, p. 154, t. 4, f. 35; and West, 'Alg. aq. dulc. Lusitan.' 1892, p. 1502).

Borge has described a "forma *major*" from South Patagonia, but in size this form scarcely exceeds the dimensions of some of the common and widely distributed forms (consult Borge, 'Süsswasseralgen Süd-Patagon.' 1901, p. 24, t. 1, f. 7; length 32–36 μ; breadth 23–26 μ).

The smallest known forms have been described from Central and West-central Africa (*C. læve* var. *minimum* West & G. S. West, 'Welw. Afric. Freshw. Algæ,' 1897, p. 119, t. 368, f. 6).

Var. **octangularis** (Wille) *nob.* (Pl. LXXIII, fig. 20.)

Cosmarium Meneghinii Bréb. forma *octangularis* Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 43, t. 12, f. 35; Boldt, Desmid. Grönland, 1888, p. 13; West, Alg. W. Ireland, 1892, p. 148; Alg. Engl. Lake Distr. 1892, p. 726; West & G. S. West, Alg. S. England, 1897, p. 487; G. S. West, Alga-fl. Cambr. 1899, p. 216; West & G. S. West, Alga-fl. Yorks. 1900, p. 93; Alg. N. Ireland, 1902, p. 35; Freshw. Alg. Orkneys and Shetlands, 1905, p. 22.

C. læve Rabenh. var. *undulata* Schmidle, Alg. Geb. Oberrheins, 1893, p. 548, t. 28, f. 5; Beitr. alp. Algenfl. 1896, p. 387; Lappmark Süsswasseralgen, 1898, p. 27.

Semicells angular, irregularly 8-sided including the broad base; each lateral margin consisting of three short, straight, or very slightly concave sides; apex retuse as in the type.

Length 21–25 μ; breadth 17–19 μ; breadth of isthmus 6·5–7·5 μ.

England.—Cumberland! Westmoreland! W., N., and E. Yorks! Cambs! Oxfordshire! Middlesex! Surrey! Kent! Cornwall!

Wales.—Llyn-an-afon, Carnarvonshire!

Scotland. — Rhiconich, Sutherland! Inverness! Perth! Orkneys! Shetlands!

Ireland.—Not uncommon! Plankton of Lough Corrib, Galway!

Geogr. Distribution.—Germany. Sweden. Portugal. Bosnia. Nova Zembla. Greenland. Azores. United States.

This variety has usually been regarded as one of the forms of *C. Meneghinii*, but we think it has greater affinities with *C. læve* than with *C. Meneghinii*. It has a wide distribution in the British Islands, but does not appear ever to be abundant.

Var. **septentrionale** Wille. (Pl. LXXIII, figs. 22–25.)

C. læve Rabenh. var. *septentrionale* Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 43, t. 12, f. 34; West, Desm. Massachusetts, 1889, p. 18, t. 3, f. 19; De Toni, Syll. Alg. 1889, p. 935; West & G. S. West, Alg. S. England, 1897, p. 487; G. S. West, Alga-fl. Cambr. 1899, p. 216; Variation Desm. 1899, p. 387, t. 10, f. 7–9; West & G. S. West, Alga-fl. Yorks. 1900, p. 94; Freshw. Alg. Ceylon, 1902, p. 166; Alg. N. Ireland, 1902, p. 35; Scott. Freshw. Plankton, I. 1903, p. 527; Freshw. Alg. Orkneys and Shetlands, 1905, p. 23.

Cells hexagonal; semicells with rectangular basal angles, lower third of the sides parallel or slightly outwardly divergent, upper two-thirds (superior lateral margins) convergent, straight, slightly retuse, or biundulate, apex narrowly truncate and retuse (sometimes almost emarginate); vertical view with subtruncate poles; side view of semicell broadly or narrowly ovate-elliptic. Cell-wall smooth.

Length 24–28 μ; breadth 15–22 μ; breadth of isthmus 4·8–6·5 μ; thickness 9–13 μ.

England.—Westmoreland! Lancashire! W. and N. Yorks! Leicestershire (*Roy*). Essex! Cambs! Middlesex! Surrey!

Scotland.—Loch Ruthven, Inverness; Slewdrum, Aberdeen; Nigg, Kincardine; Bracklin, Perth; Alva Glen, Stirling (*Roy & Bissett*). New Galloway, Kirkcudbright! Orkneys! Shetlands!

Ireland.—Donegal! Galway! Kerry! Londonderry! Down! Armagh!

Geogr. Distribution.—France. Germany. Hungary. Italy. Norway. Sweden. Nova Zembla. Ceylon. Burma. E. Africa (Somaliland). United States.

This variety is frequent in the British Islands, and the extreme forms scarcely appear to belong to *C. læve*. It is not possible to discriminate between the various forms met with, as the complete range of variation known can be found amongst individuals in the same collection, and the two halves of the same cell may be very different from each other. The variation is principally in the angularity of the semicells and in the character of the superior lateral margins, the latter often exhibiting a marked undulation.

In a pure collection from Somaliland all intermediate stages between typical *C. læve* and the var. *septentrionale* were observed.

Var. **cymatium** West & G. S. West (Pl. LXXIII, fig. 21.)

C. læve Rabenh. var. *cymatium* West & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 23, t. 1, f. 19.

Basal angles of semicells somewhat less rounded than the average, lateral margins minutely undulate.

Length 24–27 μ; breadth 17–18 μ; breadth of isthmus 4·6–5 μ.

Scotland.—Hoy, Orkneys!

This variety is at once distinguished by the regular and minute undulation of the lateral margins of the semicells.

114. **Cosmarium monochondrum** Nordst. (Pl. LXXIII, fig. 26.)

Cosmarium monochondrum Nordst. Norges Desm. 1873, p. 17, t. 1, f. 6; De Toni, Syll. Alg. 1889, p. 1002; Roy & Biss. Scott. Desm. 1894, p. 169; Nordst. Index Desm. 1896, p. 175.

Ursinella monochondra Kuntze, Revis. gen. plant. 1891, p. 925.

Cells minute, about as long as broad, deeply constricted, sinus open and subrectangular, with an acuminate apex; semicells obversely subsemicircular (or elliptic-cuneate with convex sides which widely diverge upwards), angles slightly produced and obtuse, apex very broad and slightly convex, with a small wart in the centre of the semicell. Side view of semicell subcircular, with a minute protuberance at the middle on each side. Vertical view rhomboid-elliptic, ratio of axes about 1 : 1·5, with a small rounded wart at the middle on each side, poles minutely produced. Cell-wall thin and smooth.

Zygospore unknown.

Length 12–13 μ; breadth 12–13 μ; breadth of isthmus 7 μ; thickness 9 μ.

Scotland.—Loch Ruthven, Inverness; Dinnet, Birsemore Loch, and south side of Birsemore, Aberdeen (*Roy & Bissett*).

Geogr. Distribution.—Norway.

We have not seen this species. Perhaps it is nearly related to *C. Sphagnicolum*.

115. **Cosmarium Thwaitesii** Ralfs.

(Pl. LXXIII, figs. 27, 28.)

Cosmarium Thwaitesii Ralfs, Brit. Desm. 1848, p. 109, t. 17, f. 8; Arch. in Pritch. Infus. 1861, p. 735; Rabenh. Flor. Europ. Alg. III, 1868, p. 175; Lund. Desm. Suec. 1871, p. 47, 52; West, Alg. W. Ireland, 1892, p. 163; Alg. Engl. Lake Distr. 1892, p. 729; Roy & Biss. Scott. Desm. 1894, p. 176; Gutw. Flor. Glon. Okolic Tarnapola, 1894, p. 83; Nordst. Index Desm. 1896, p. 254; West & G. S. West, Alg. S. England, 1897, p. 492; Alga-fl. Yorks. 1900, p. 94.

Dysphinctium Thwaitesii Reinsch, Algenfl. Franken, 1867, p. 177; De Toni, Syll. Alg. 1889, p. 890.

Cosmarium Thwaitesii a. *typicum* Klebs, Desm. Ostpreuss. 1879, p. 26.

Calocylindrus Thwaitesii (Ralfs) Schaarschm. in Magyar Növén. Lapok. vi, 1882, p. 73; ? Wolle, Desm. U. S. 1884, p. 56, [t. 12, f. 19], t. 50, f. 28; Cooke, Brit. Desm. 1887, p. 126, t. 44, f. 5; West, Alg. N. Yorks. 1889, p. 293; Alg. N. Wales, 1890, p. 291.

Cells of moderate size, 2–2$\frac{1}{2}$ times as long as broad, slightly constricted; semicells oblong or subelliptic-oblong, sides subparallel, slightly convex, and very faintly converging upwards, apex rounded or slightly

truncately rounded. Side view of semicell slightly narrower than front view. Vertical view very broadly oblong-elliptic. Cell-wall minutely and indistinctly punctate. Chloroplasts axile, one in each semicell, each with two pyrenoids transversely disposed.

Zygospore unknown.

Length 58–75 μ; breadth 26·5–30·5 μ; breadth of isthmus 20–29 μ; thickness 24–26 μ.

England.—Westmoreland! (*Bissett*). W. and N. Yorks! Gloucestershire (*Ralfs*). Middlesex! Surrey! Devon!

Wales.—Capel Curig, Carnarvonshire! Dolgelly, Merionethshire! Swansea, Glamorganshire (*Ralfs*).

Scotland.—Aberdeen, Kincardine, Forfar, Perth! (*Roy & Bissett*).

Ireland.—Loughs Aunierin and Derryclare, Galway! Sugarloaf Mountain and Carrantuohill, Kerry! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Austria and Galicia. Hungary. Italy. Bornholm. Norway. Sweden. Finland. Poland. Russian Lapland. N. and S. Russia. Franz Joseph Land. New Zealand. Abyssinia. United States.

C. Thwaitesii, although widely distributed, is relatively a rare species. We have only found isolated individuals among submerged *Sphagnum*.

Var. **penioides** Klebs. (Pl. LXXIII, figs. 29, 30.)

Cosmarium Thwaitesii Ralfs b. *penioides* Klebs, Desm. Ostpreuss. 1879, p. 26, t. 3, f. 5–7; Borge, Chlor. Norska Finmark. 1892, p. 11 [forma]; Lütkem. Desm. Attersees, 1893, p. 555; Borge, Süssw. Chlor. Archang. 1894, p. 22.

Cells stouter than in the type and proportionately shorter, sides of semicells more convex.

Length 54–68 μ; breadth 27–31 μ; breadth of isthmus 22–26 μ.

Scotland.—Near Aberdeen!

Geogr. Distribution.—Germany. Austria. Sweden. N. Russia.

116. **Cosmarium Cucurbita** Bréb.

(Pl. LXXIII, figs. 31–33; Pl. LXXIV, fig. 3.)

Cosmarium Cucurbita Bréb. in Desmazières' Pl. Crypt. France, fasc. 23, 1841, no. 1103, cum fig.; Ralfs in Ann. Mag. Nat. Hist. 1844, p. 395, t. 11, f. 10; Ralfs, Brit. Desm. 1848, p. 108, t. 17, f. 7; Bréb. Liste Desm. 1856, p. 132; Arch. in Pritch. Infus. 1861, p. 735; Rabenh. Flor. Europ. Alg. III, 1868, p. 174; Lund. Desm. Suec. 1871, p. 51; Elfv. Anteck. Finska Desm. 1881, p. 14; Arch. in Ann. Mag. Nat. Hist. ser. 5, xvi, p. 145; West, Alg. W. Ireland, 1892, p. 162; Alg. Engl. Lake Distr. 1892, p. 729; Lütkem. Desm. Attersees, 1893, p. 549; Roy & Biss. Scott. Desm. 1894, p. 44; Nordst. Index Desm. 1896, p. 92; West & G. S. West, Welw. Afric. Freshw. Alg. 1897, p. 176; Alg. S. England, 1897, p. 492; Alga-fl. Yorks. 1900, p. 94; Lütkem. Desm. Millstättersees, 1900, p. 8; Börg. Freshw. Alg. Færoës, 1901, p. 220; West & G. S. West, Alg. N. Ireland, 1902, p. 41; Larsen, Freshw. Alg. E. Greenland, 1904, p. 84; West & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 23; Borge, Beiträge Alg. Schweden, 1906, p. 35.

Dysphinctium Cucurbita (Bréb.) Grun. in Verhand. d. zool.-bot. Ges. Wien, 1858, p. 492; Reinsch, Algenfl. Frank. 1879, p. 179 [in part]; De Toni, Syll. Alg. 1889, p. 881; Turn. Freshw. Alg. E. India, 1893, p. 44; Schmidle, Beitr. Algenfl. Schwarzwald. u. Rheineb. 1893, p. 92; Lappmark Süsswasseralgen, 1898, p. 19.

Calocylindrus Cucurbita (Bréb.) Kirchn. Alg. Schles. 1878, p. 143; Wolle, Desm. U. S. 1884, p. 54, t. 12, f. 14; Cooke, Brit. Desm. 1887, p. 125, t. 44, f. 7; Hansg. Prodr. Algenfl. Böhm. 1888, p. 185; West, Alg. N. Wales, 1890, p. 291; Schmidt, Grundl. Algenfl. Lüneburg. Heide, 1903, p. 34.

Cosmarium Palangula Bréb. var *Debaryi* Rabenh. Flor. Europ. Alg. III, 1868, p. 174 [= *C. Palangula* De Bary, Conj. 1858, p. 72, t. 6, f. 51]; Nordst. Alg. aq. dulc. et. Char. Sandvic. 1878, p. 13; Wille, Norges Ferskv. Alg. 1880, p. 37; West, Alg. W. Ireland, 1892, p. 162; Alg. Engl. Lake Distr. 1892, p. 729; Lütkem. Desm. Attersees, 1893, p. 549; Borge, Beiträge Alg. Schweden, 1906, p. 35.

Dysphinctium Debaryi Heimerl, Desm. alpin. 1891, p. 593.

Cells small, almost cylindrical, about twice as long as broad, slightly constricted, sinus a slight notch; semicells subquadrate, lateral margins subparallel and very slightly convex, upper angles rounded, apex convex or convex-truncate. Vertical view circular. Cell-wall punctate. Chloroplasts axile, one in each semicell, with a central pyrenoid and several very irregular ridges.

Zygospore globose and verrucose.

Length 29–51 μ; breadth 15–24 μ; breadth of isthmus 14–21 μ; diam. zygosp. without warts 30–37 μ.

England. — Cumberland! Westmoreland! (*Ralfs*). Lancashire! W. and N. Yorks (up to 2000 ft., with zygospores on Whernside)! Cheshire (*Ralfs*). Warwick!

(*Wills*). Gloucester (*Ralfs*). Surrey (zygospores from Thursley Common)! Sussex (*Ralfs*). Kent! Hants! Wilts! Devon! Cornwall!

Wales.—Common! At 2700 ft. on Glyder Fawr and at 2200 ft. on Glyder Fach, Carnarvonshire!

Scotland.—General! (*Roy & Bissett*). Common in the Outer Hebrides! Orkneys! Shetlands!

Ireland.—General, but not very abundant!

Geogr. Distribution.—France. Germany. Austria and Galicia. Hungary. Italy. Norway. Sweden. Denmark. Finland. Poland. N. and S. Russia. Faeroes. Greenland. Singapore. Australia. W. Africa. United States. W. Indies.

C. Cucurbita occurs most abundantly in *Sphagnum*-bogs, and is frequently associated with *Euastrum insigne*, *Xanthidium armatum*, *Arthrodesmus Incus*, *Gymnozyga moniliformis*, and other bog-loving species. It is distinguished by its shortly cylindrical cells, with the evident median constriction, by the strongly punctate cell-wall, and by the single central pyrenoid in each axile chloroplast. The poles of the cell exhibit much variation in form; sometimes they are hemispherical, but more often considerably flattened. The species varies greatly in size, the smallest known form (var. *minimum* W. & G. S. West, 'Welw. Afric. Freshw. Alg.' 1897, p. 176) having a length of only 12·5 μ and a breadth of 7·5 μ. The average size of the British examples is about 40 μ in length and 20 μ in breadth.

We are convinced that the Desmid which has frequently been recorded as "*C. Palangula* Bréb. var. *Debaryi* Rabenh." is only one form of *C. Cucurbita*, as it agrees with the latter species in all its essential features.

The adult zygospores of *C. Cucurbita* are globose and verrucose. We had at one time described them as smooth (*vide* West, in 'Naturalist,' Aug. 1891, p. 246; W. & G. S. West, 'Alg. S. England,' 1897, p. 492, t. 6, f. 26), but have since found that these zygospores were immature.

Forma **major**. (Pl. LXXIV, fig. 2.)

C. Cucurbita forma *major* West, Alg. W. Ireland, 1892, p. 162.

Length 60 μ; breadth 30 μ; breadth of isthmus 25 μ.

Ireland.—Ballynahinch, Galway!

Forma **latior**. (Pl. LXXIV, fig. 1.)

C. Cucurbita forma *major* et *latior*, West, Alg. Engl. Lake Distr. 1892, p. 729.

Length 42 μ; breadth 27 μ.

England.—Kirk Fell, Cumberland! Loughrigg, Grisedale Tarn, and Brandreth, Westmoreland!

Var. **attenuatum** G. S. West. (Pl. LXXIII, figs. 34–36.)

Dysphinctium Cucurbita (Bréb.) Hansg. forma ad apices versus attenuata ibique late rotundato-truncata, Schmidle, Beitr. alp. Alg. 1895, p. 347, t. 14, f. 16.

Cosmarium Cucurbita Bréb. var. *attenuatum* G. S. West, W. Indian Freshw. Alg. 1904, p. 286, t. 464, f. 18.

Semicells distinctly attenuated towards the apices, which are rounded-truncate.

Length 24–46 μ; breadth 15·2–22 μ; breadth of apex about 10–12 μ; breadth of isthmus 14–20 μ.

England.—Mickle Fell, N. Yorks! New Forest, Hants!

Geogr. Distribution.—Germany. W. Indies.

This variety is usually somewhat smaller than typical *C. Cucurbita*. The attenuation of the semicells is sometimes very marked, but many intermediate states exist.

117. **Cosmarium Palangula** Bréb.

(Pl. LXXIV, figs. 4, 5.)

Penium Palangula Bréb. in Dict. universelle d'hist. natur. Paris, vol. iv, 1844, p. 513.

Cosmarium Palangula Bréb. in Ralfs' Brit. Desm. 1848, p. 212; Bréb. Liste Desm. 1856, p. 132, t. 1, f. 21; Arch. in Pritch. Infus. 1861, p. 735; De Not. Desm. Ital. 1867, p. 41, t. 3, f. 24; Rabenh. Flor. Europ. Alg. III, 1868, p. 174; Anderss. Sverig. Chlor. 1890, p. 15; West, Alg. W. Ireland, 1892, p. 162; Lütkem. Desm. Attersees, 1893, p. 549; Roy & Biss. Scott. Desm. 1894, p. 170; Nordst. Index Desm. 1896, p. 193; Lütkem. Desm. Millstättersees, 1900, p. 10; West & G. S. West, Alga-fl. Yorks. 1900, p. 94; Borge, Alg. erst. Regnell. Exped., II. Desmid. 1903, p. 93; Beiträge Alg. Schweden, 1906, p. 35.

C. Palangula Bréb. a. *genuinum* Rabenh. Flor. Europ. Alg. III, 1868, p. 175.

Calocylindrus Palangula (Bréb.) Kirchn. Alg. Schles. 1878, p. 143; Cooke, Brit. Desm. 1887, p. 125, t. 44, f. 9; West, Alg. N. Wales, 1890, p. 291.

Dysphinctium Palangula (Bréb.) Hansg. in Österr. Bot. Zeitschr. xxxvii, 1887, p. 99; Prodr. Algenfl. Böhm. 1888, p. 184; De Toni, Syll. Alg. 1889, p. 879; Schmidle, Lappmark Süsswasseralgen, 1898, p. 19.

Cells small, subcylindrical, about $2\frac{1}{2}$–3 times as long

as broad, with a slight median constriction; semicells subrectangular, upper and lower angles rounded, apex rounded-truncate or subtruncate. Vertical view circular. Cell-wall finely punctate-scrobiculate, with the punctulations disposed in close transverse series. Chloroplasts axile, one in each semicell, with a central pyrenoid and a number of longitudinal ridges.

Zygospore unknown.

Length 32–48 μ; breadth 14–17 μ; breadth of isthmus 13–15·5 μ.

England.—Cocket Moss, near Giggleswick, Cowside Beck, Arncliffe, and Old Cote Moor, W. Yorks! Subfossil in peat deposit at Filey, E. Yorks!

Wales.—Capel Curig! and Pen-y-gwryd (*Roy*), Carnarvonshire.

Scotland.—Poolewe, Ross; near Brin, Inverness; Glen Callater, Aberdeen; Canlochan, Forfar; Rannoch, Perth; Alva Glen, Stirling (*Roy & Bissett*).

Ireland.—Lower Lake of Killarney and Glen Caragh, Kerry!

Geogr. Distribution.—France. Germany. Austria and Galicia. Hungary. Italy. Norway. Sweden. Finland. N. Russia. Azores. Sandwich Islands. United States. Guiana. Brazil.

This species is closely allied to *C. Cucurbita*, but differs in its relatively greater length, and in the transversely arranged and more crowded punctulations of the cell-wall.

118. **Cosmarium subpalangula** Elfv.

(Pl. LXXIV, fig. 7.)

Cosmarium subpalangula Elfv. Anteck. Finska Desm. 1881, p. 14, t. 1, f. 11; Roy & Biss. Scott. Desm. 1894, p. 175; Nordst. Index Desm. 1896, p. 246.

Dysphinctium subpalangula (Elfv.), De Toni, Syll. Alg. 1889, p. 882.

Cells small, about $1\frac{1}{2}$ times as long as broad, doliform, very slightly constricted; semicells ovate-truncate, sides convex and convergent upwards, apex broadly truncate. Vertical view circular. Cell-wall indistinctly granulate, granules in about 4 transverse

series. Chloroplasts axile, one in each semicell, with a central pyrenoid.

Zygospore unknown.

Length 28–32 μ; breadth 20–21 μ.

Scotland.—Birsemore Loch, Aberdeen (*Roy & Bissett*).

Geogr. Distribution.—Finland.

Messrs. Roy and Bissett record this species as "very rare" in the one locality in which they found it in Aberdeenshire. The granules are stated by Elfving to be indistinct, and Lagerheim has described a form from Sweden (forma *depauperata*) in which they are not present; *vide* Lagerh. in 'Bot. Notiser,' 1886, p. 47.

119. **Cosmarium parvulum** Bréb.

(Pl. LXXIV, figs. 8–10.)

Cosmarium parvulum Bréb. Liste Desm. 1856, p. 133, t. 1, f. 18; Arch. in Pritch. Infus. 1861, p. 735; Rabenh. Flor. Europ. Algar. III, 1868, p. 177; Lund. Desm. Suec. 1871, p. 50 (forma); Nordst. Alg. aq. dulc. et Char. Sandvic. 1878, p. 13; Gay, Monogr. loc. Conj. 1884, p. 72; Lagerh. Bidrag Amerik. Desm.-fl. 1885, p. 241; Cooke, Brit. Desm. 1887, p. 120, t. 43, f. 8; Boldt, Desmid. Grönland, 1888, p. 11; De Toni, Syll. Alg. 1889, p. 958; Borge, Süssw. Chlor. Archang. 1894, p. 22; Roy & Biss. Scott. Desm. 1894, p. 170; Nordst. Index Desm. 1896, p. 196; West & G. S. West, Alga-fl. Yorks. 1900, p. 95; Alg. N. Ireland, 1902, p. 41.

Ursinella parvula Kuntze, Revis. gen. plant. 1891, p. 925.

Cosmarium obcuneatum West, Alg. W. Ireland, 1892, p. 162, t. 21, f. 18; Alg. Engl. Lake Distr. 1892, p. 729, t. 9, f. 8 [forma]; West & G. S. West, Alg. S. England, 1897, p. 492.

Dysphinctium parvulum (Bréb.) Schmidle, Beitr. alp. Alg. 1895, p. 348.

Cells small, 2–2½ times longer than broad, very slightly constricted, sinus a minute notch; semicells narrowly truncate-pyramidate, sides commonly very slightly convex, but sometimes straight or very slightly concave, upper angles slightly rounded, apex truncate, slightly convex, straight, or rarely very slightly concave. Vertical view almost exactly circular. Cell-wall smooth, or delicately and irregularly punctate. Chloroplasts axile, one in each semicell, with a central pyrenoid and a number of small longitudinal ridges.

Zygospore . . . ?

Length 30–42 μ; breadth 14–17 μ; breadth of apex 7·5–9·5 μ; breadth of isthmus 13–14·5 μ.

England.—Near Bowness! (*Bissett*), Pike of Bliscoe, Loughrigg, Grisedale Tarn, and Helvellyn, Westmoreland! Pilmoor, near Thirsk, and Carlton Bank, N. Yorks! Dartmoor, Devonshire!

Wales.—Bog above Capel Curig Lakes, Bog below Llyn Idwal, Twll Du, Llyn Gwynant, and Snowdon, Carnarvonshire!

Scotland.—Lochinver, Sutherland; Ross; Brin and Skye, Inverness!; Slewdrum, Aberdeen; Cammie, Muiryhaugh, Dalbrake and Glen Dye, Kincardine; Fife; near Kingshouse, Argyll (*Roy & Bissett*). Ben Laoigh, Argyll!

Ireland.—Doochary Bridge and Sproule's Lough, Donegal! Cromagloun, Kerry (with zygospores?)! Slieve Donard and Slieve Commedagh (at 2000 ft.), Down! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Galicia in Austria. Bosnia. Norway. Sweden. N. Russia. Nova Zembla. Spitzbergen. Greenland. Ceylon. Singapore. Azores. Sandwich Islands (form). United States. Brazil. Patagonia.

C. parvulum is sharply marked off from *C. Cucurbita* by the pyramidate and more angular semicells, with almost straight lateral margins. It is slightly shorter than *C. Palangula*, with pyramidate semicells, and a cell-wall of a different nature.

There is no doubt that *C. obcuneatum* is identical with *C. parvulum*, but we are in doubt concerning the zygospore referred to *C. obcuneatum*, and described from Cromagloun, Kerry. This zygospore was globose and 29 μ in diameter, being furnished with numerous simple spines 10–12 μ in length. We have since had reason to suspect that this zygospore may have belonged to *Penium adelochondrum* Elfv.

120. **Cosmarium goniodes** West & G. S. West. (Pl. LXXIV, figs. 12, 13.)

Cosmarium goniodes West & G. S. West, Alg. Madag. 1895, p. 70, t. f. 8; Nordst. Index Desm. 1896, p. 131; West & G. S. West, Alg. England, 1897, p. 492.

Cells small, about twice as long as broad, slightly constricted, sinus very small and open; semicells sub-

cuneate-quadrate, sides straight or substraight and very slightly divergent upwards, basal angles a little rounded, upper angles obliquely truncate, apex truncate and slightly retuse. Vertical view circular or somewhat compressed. Cell-wall smooth. Chloroplasts axile, one in each semicell, with a small central pyrenoid.

Zygospore unknown.

Length 14·5–20 μ; breadth 7·5–9·5 μ; breadth of isthmus 5·5–6 μ.

England.—Thursley Common, Surrey!

Geogr. Distribution.—Madagascar.

Var. **subturgidum** West & G. S. West. (Pl. LXXIV, fig. 14.)

Cosmarium parvulum Bréb. forma, Bohlin, Flor. algol. d'eau douce d. Açores, 1901, p. 67, t. 1, f. 30.

C. goniodes var. *subturgidum* West & G. S. West, Alg. N. Ireland, 1902, p. 41, t. 2, f. 12.

Semicells with slightly convex sides and somewhat more retuse apices; vertical view elliptic-circular. Cells commonly twisted at the isthmus.

Length 18–19·2 μ; breadth 8·6–9·4 μ; breadth of isthmus 6·7 μ; thickness 7·8–8 μ.

Ireland.—Loughs Machugh and Magrath, and near Glenties, Donegal!

Geogr. Distribution.—Azores. Australia.

Var. **variolatum** West & G. S. West. (Pl. LXXIV, fig. 15.)

C. goniodes var. *variolatum* West & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 23, t. 1, f. 18.

Cells relatively shorter and commonly twisted at the isthmus; semicells slightly attenuated, superior angles rounded. Side view of semicell ovate-pyramidate. Vertical view broadly elliptic. Cell-wall punctulate, punctulations very delicate and distant, 6–9 visible in the front view of each semicell.

Length 20–21·3 μ; breadth 10·6–12·2 μ; breadth of isthmus 8·5–8·8 μ; thickness 8·5 μ.

Scotland.—Near Scalloway, Shetlands!

This variety is nearer var. *subturgidum* than the typical form. It is characterized by its shorter semicells, its rounded apical angles, and its delicately variolated cell-wall.

121. **Cosmarium viride** (Corda) Josh.
(Pl. LXXIV, figs. 16–18.)

Colpopelta viridis Corda in Alm. de Carlsbad, 1834, pp. 179, 206, t. 2, f. 28; 1839, p. 241.
Cosmarium Cordanum Bréb. in Rabenh. Flor. Europ. Alg. III, 1868, p. 177; Turner, New and Rare Desm. 1885, p. 934, t. 15, f. 4 [figure bad]; West, Desm. Mass. 1889, p. 18, t. 3, f. 23; Borge, Süssw. Chlor. Archang. 1894, p. 23.
C. viride (Corda) Joshua, New and Rare Desm. 1885, p. 34, t. 254, f. 3; Johnson, Rare Desm. U. S. II, 1895, p. 292; West & G. S. West, Alg. Madag. 1895, p. 71, t. 9, f. 27; Nordst. Index Desm. 1896, p. 271; West & G. S. West, Some Desm. U. S. 1898, p. 311.
Calocylindrus Cordanus Wolle, Freshw. Alg. U. S. 1887, p. 27, t. 60, f. 28.
Dysphinctium Cordanum Hansg. Prodr. Algenfl. Böhm. 1888, p. 186.
D. viride De Toni, Syll. Alg. 1889, p. 885; Turner, Freshw. Alg. E. India, 1893, p. 40.

Cells somewhat small, about $1\frac{3}{4}$ times longer than broad, moderately constricted, sinus a very obtuse-angled depression; semicells obovate-circular, widest part about one-third from the apex, apices commonly very slightly depressed. Vertical view circular. Cell-wall punctate. Chloroplasts axile, one in each semicell, with a central pyrenoid.

Zygospore unknown.

Length 41–55 μ; breadth 20–33 μ; breadth of isthmus 14–22 μ.

England.—Ennerdale, Cumberland!

Ireland.—Lakes between Clifden and Roundstone, Galway!

Geogr. Distribution.—France. Germany. Bohemia. India. Madagascar. United States. Nova Scotia.

C. viride is a very rare species which is distinguished from *C. moniliforme* by the broader isthmus and the somewhat different form of the semicells, as well as by its punctate cell-wall.

Forma **minor** West. (Pl. LXXIV, fig. 19.)

C. viride forma *minor* West, Alg. W. Ireland, 1892, p. 161.

Length 31–32·5 μ; breadth 18–19 μ; breadth of isthmus 12·5–15 μ.

Ireland.—Ballynahinch and Lough Derryclare, Galway!

Forma **glabra** *nob.* (Pl. LXVII, figs. 11–13.)

Dysphinctium globosum forma *subviride* Schmidle, Beitr. Algenfl. Schwarzwald. u. Rheineb. 1893, p. 91, t. 6, f. 13.
Cosmarium moniliforme forma *subviride* Schmidle, Chloroph.-Fl. Torfstiche Virnheim, 1894, p. 51, t. 7, f. 7.

Cell-wall smooth.

Length 34–39 μ; breadth 18–22 μ; breadth of isthmus 14–16 μ.

Scotland.—Harris, Outer Hebrides!

Geogr. Distribution.—Germany.

The outward form of the semicells differs in no way from that of typical *C. viride*, whereas its broad isthmus and obovate semicells at once distinguish it from *C. moniliforme*.

122. **Cosmarium oblongum** Bennett. (Pl. LXXIV, fig. 20.)

Cosmarium sp. Reinsch, Contrib. Alg. et Fung. 1867, p. 82, t. 12, f. 3.
Cosmarium oblongum Benn. Freshw. Alg. Engl. Lake Distr. 1886, p. 10, t. 1, f. 16; Nordst. Index Desm. 1896, p. 185.
Calocylindrus oblongus Cooke, Brit. Desm. 1887, p. 123, t. 44, f. 8.
Dysphinctium oblongum De Toni, Syll. Alg. 1889, p. 891.

Cells somewhat small, about $2\frac{1}{2}$ times as long as broad, moderately constricted, sinus very obtuse-angled; semicells oblong- or ovate-elliptic. Cell-wall smooth. Chloroplasts . . . ?

Zygospore unknown.

Length 53 μ; breadth 22 μ; breadth of isthmus 15 μ.

England.—Loughrigg, Westmoreland (*Bennett*).

Geogr. Distribution.—France.

We have not seen this species. It should be compared with *C. moniliforme* forma *elongata*.

123. **Cosmarium Hibernicum** West. (Pl. LXXIV, fig. 21.)

Cosmarium Hibernicum West, Alg. W. Ireland, 1892, p. 163, t. 21, f. 19; Nordst. Index Desm. 1896, p. 139.

Cells somewhat large, about twice as long as broad,

slightly constricted, sinus a wide and shallow depression; semicells broadly oblong-elliptic (subrotund), apex broadly rounded. Vertical view circular. Cell-wall smooth. Chloroplasts parietal, several in each semicell, in the form of rather narrow and irregular longitudinal bands, each with several small pyrenoids.

Zygospore unknown.

Length 90 μ; breadth 45 μ; breadth of isthmus 37 μ.

Ireland.—Small lakes between Clifden and Roundstone, and near Ballynahinch, Galway!

This species is distinguished both by its outward form and its peculiar chloroplasts. It was obtained in two localities in the west of Ireland in 1890, but we have not seen it since.

124. **Cosmarium turgidum** Bréb.
(Pl. LXXV, figs. 1–3.)

Cosmarium turgidum Bréb. in Ralfs' Brit. Desm. 1848, p. 110, t. 32, f. 8; Arch. in Pritch. Infus. 1861, p. 735; Lund. Desm. Suec. 1871, p. 51; Nordst. Freshw. Alg. N. Zeal. 1888, p. 63; Gutw. Flor. Glon. Ökolic Lwowa, 1891, p. 38; West, Alg. Engl. Lake Distr. 1892, p. 729; Lütkem. Desm. Millstättersees, 1900, p. 12.

Pleurotænium turgidum De Bary, Conj. 1858, p. 75, t. 5, f. 31; Bulnh. in Hedwigia, 1859, p. 21, t. 2, f. 9; Rabenh. Flor. Europ. Alg. III, 1868, p. 144, c. fig. xylogr. p. 104; Hauptfl. Zellmembr. u. Hüllgallerte Desm. 1888, p. 83, t. 2, f. 42, 47.

Dysphinctium turgidum Grun. in Verh. d. zool. bot. Ges. Wien, 1858, pp. 493, 500; Reinsch, Algenfl. Frank. 1867, p. 179; Delp. Desm. subalp. 1877, p. 133, t. 21, f. 16; Heimerl, Desm. alp. 1891, p. 594.

Docidium turgidum Wittr. Skandinav. Desm. 1869, p. 20.

Calocylindrus turgidus (Bréb.) Kirchn. Alg. Schles. 1878, p. 142; Cooke, Brit. Desm. 1887, p. 127, t. 44, f. 1.

Cosmarium Debaryi c. *turgidum* Klebs, Desm. Ostpreuss. 1879, p. 28.

Cosmaridium turgidum Hansg. Prodr. Algenfl. Böhm. 1888, p. 245.

Pleurotæniopsis turgidus (Bréb.) De Toni, Syll. Alg. 1889, p. 907; Möbius, Austral. Süsswasseralg. 1892, p. 442; Lütkem. in Österr. botan. Zeitschr. xliii, 1893, p. 43, t. 3, f. 26.

Cells very large, 2–2$\frac{1}{3}$ times as long as broad, slightly constricted, sinus a rounded notch; semicells ovate-truncate from a broad base, lower angles slightly rounded, sides slightly convex and converging upwards, apex truncately rounded. Vertical view circular. Cell-wall minutely scrobiculate. Chloroplasts parietal, in the form of somewhat irregular longitudinal bands, 8 in each semicell, with several pyrenoids in each.

Zygospore unknown.

Length 184–220 μ; breadth 88–100 μ; breadth of isthmus 70–84 μ.

England.—Near Bowness! (*Bissett*) and Loughrigg (*Bennett*), Westmoreland. Hawkshead, Lancashire! Henfield, Sussex (*Ralfs*). New Forest, Hants. (*Bennett*).

Wales.—Near Swansea, Glamorganshire (*Ralfs*).

Geogr. Distribution.—France. Germany. Austria and Galicia. Bosnia. Sweden. Italy. Denmark. Bornholm. Poland. S. Russia. Japan. Australia. New Zealand. Patagonia (form).

C. turgidum is one of the largest and most characteristic species of the genus. We have only observed it in abundance from near Bowness, Westmoreland.

The parietal band-like chloroplasts are sometimes continuous from end to end of the cell.

Var. **subrotundatum** West. (Pl. LXXV, fig. 4.)

C. turgidum var. *subrotundatum* West, Alg. Engl. Lake Distr. 1892, p. 729.

Cells about twice as long as broad; semicells inflated and subcircular.

Length 140 μ; breadth 77 μ; breadth of isthmus 60 μ.

England.—Bowness, Westmoreland!

Schmidle has suggested that the outline of this form was due to distortion under pressure (*vide* Schmidle in 'Hedwigia,' xxxiv, 1895, p. 73). Many Desmids possess cell-walls sufficiently elastic to exhibit considerable distortion under pressure before they rupture at the isthmus. This variety, however, does not owe the rounded form of its semicells to such a cause. It was most likely produced by vegetative cell-division, as we have observed several young semicells of a similar outward shape which have undoubtedly arisen as a result of abnormal cell division. Consult also Delp. 'Desm. subalp.' 1877, t. 21, f. 5!

125. **Cosmarium subturgidum** (Turn.) Schmidle. (Pl. LXXV, fig. 5.)

Dysphinctium subturgidum Turn. Freshw. Alg. E. India, 1893, p. 40, t. 7, f. 4.

Cosmarium subturgidum (Turn.) Schmidle, Alg. aus Sumatra, 1895, p. 300.

Cells very large, about twice as long as broad, slightly constricted, sinus a shallow depression; semicells widely ovate from a broad base, apex subtruncately rounded; cell-wall somewhat sparsely punctate. Vertical view circular.

Zygospore unknown.

Length 140–150 μ; breadth 66–74 μ; breadth of isthmus 60–64 μ.

Geogr. Distribution.—India.

The typical form of this species is not known to occur in the British Islands. It differs from *C. turgidum* in its somewhat smaller size, its more rounded semicells, and less truncate apices.

Forma **minor** Schmidle. (Pl. LXXIV, figs. 22, 23.)

C. subturgidum forma *minor* Schmidle, Alg. aus Sumatra, 1895, p. 300, t. 4, f. 2; West & G. S. West, Freshw. Chlor. Koh Chang, 1901, p. 92.
Pleurotæniopsis subturgida (Turn.) Schmidle var. *minor* Schmidle, Süsswasseralg. Austral. 1896, p. 305.

A smaller variety, slightly less constricted than the type; semicells with slightly broader apices (more as in *C. turgidum*) which are sometimes very faintly retuse in the middle. Chloroplasts parietal, 4–5 in each semicell in the form of longitudinal bands, with several pyrenoids.

Length 88–120 μ; breadth 52–64 μ; breadth of isthmus 49–59 μ.

Ireland.—Small lakes between Clifden and Roundstone, Galway!

Geogr. Distribution. — Siam. Sumatra. Samoa. Australia. E. Africa.

Schmidle describes what he considers to be the zygospore of this form from Australia. It is globose and furnished with rather long, slightly curved, and blunt spines. From his stated dimensions (diam. 27 μ; spines about 10 μ in length), however, we do not see how the zygospore can belong to a Desmid at all approaching *C. subturgidum* f. *minor* in size.

E. African forms are recorded by Schmidle as only 66 μ in length and 36 μ in breadth.

126. **Cosmarium attenuatum** Bréb.
(Pl. LXXIV, figs. 24, 25.)

Cosmarium attenuatum Bréb. in Ralfs' Brit. Desm. 1848, p. 110, t. 17, f. 9; Arch. in Pritch. Infus. 1861, p. 735; Wittr. Skandinav. Desm. 1869, p. 15; Roy & Biss. Scott. Desm. 1894, p. 42; Nordst. Index Desm. 1896, p. 54; West & G. S. West, Alga-fl. Yorks. 1900, p. 95.
Calocylindrus attenuatus Cooke, Brit. Desm. 1887, p. 127, t. 43, f. 12. [Not *Calocylindrus attenuatus* Racib. in Spraw. Kom. fizyjogr. Akad. Umiej. Krakow. xix, 1884, p. 9 = *Cosmarium elongatum* Racib. 1885.]
Dysphinctium attenuatum Turn. Freshw. Alg. of E. India, 1893, p. 44.

Cells rather small, about $2\frac{1}{2}$ times as long as broad, slightly constricted, sinus a shallow notch (generally rounded); semicells attenuate-ovate, apex narrow and rounded, not infrequently faintly retuse at the extremity. Vertical view circular. Cell-wall sparsely punctate. Chloroplasts axile, . . .?

Zygospore unknown.

Length 62–64 μ; breadth 20–27 μ; breadth of isthmus, 17·5–19·5 μ.

England. — Arncliffe and Cowgill Wold Moss, Widdale Fell, W. Yorks! Mickle Fell, N. Yorks! Near Bristol, Gloucestershire (*Thwaites*). Near Bovey Tracey, Devon (*Bennett*).

Wales.—Near Swansea, Glamorganshire (*Ralfs*).

Scotland.—Brin, Inverness (*Roy & Bissett*).

Geogr. Distribution.—France. Norway. Spitzbergen. India.

In external form this species more nearly resembles *Penium curtum* than any other Desmid. Its semicells are, however, more attenuated, and the cell-wall is differently punctated. Ralfs states that it differs chiefly from *Penium curtum* in the chloroplasts, but he neither describes nor figures this difference, and we have only examined preserved empty cells.

ADDENDA TO THE SMOOTH *COSMARIA*.

127. **Cosmarium orthogonum** Delp.
(Pl. LXVI, figs. 13, 14.)

Cosmarium orthogonum Delp. Desm. subalpin. 1877, p. 8, t. 7, f. 49–51 [" *ortogonum*"]; De Toni, Syll. Alg. 1889, p. 1006; Roy & Biss. Scott. Desm. 1894, p. 170; Nordst. Index Desm. 1896, p. 191.
Ursinella orthogona Kuntze, Revis. gen. plant. 1891, p. 925.

Cells somewhat small, about as long as broad or a little longer, deeply constricted, sinus almost linear; semicells truncate-pyramidate or widely semihexagonal, basal angles rounded or retuse-truncate, lateral margins (which in some cases are really the upper lateral margins) biundulate, with two hollows and one crest, apical angles rounded, apex widely truncate, straight or very slightly concave. Side view of semicell subcircular. Vertical view elliptic, with a broad median tumour on each side, ratio of axes about 1 : 1·7. Cell-wall coarsely punctate. Chloroplasts axile, each with a large central pyrenoid.

Zygospore unknown.

Length 61–64·8 μ; breadth 50·4–60 μ; breadth of isthmus 16·5–21 μ; thickness 30 μ.

Scotland.—Fintray Hills, Stirling (*Roy & Bissett*).

Geogr. Distribution.—Italy. Galicia in Austria. United States (var.).

C. orthogonum is closely allied to *C. Nägelianum*, of which species we have in the past regarded it merely as a variety. We have not ourselves examined any specimens of it, but Messrs. Roy and Bissett have recorded it as occurring in Scotland. Delponte's figures, which we have reproduced, indicate a considerable variability in the form of the semicells. Consult remarks on p. 15 under *C. Nägelianum*.

128. **Cosmarium Capitulum** Roy & Biss.

(Pl. LXXI, fig. 18.)

Cosmarium Capitulum Roy & Biss. Jap. Desm. 1886, p. 195, t. 268, f. 9; De Toni, Syll. Alg. 1889, p. 939; Gutw. Flor. Glon. Okolic Lwowa, 1891, p. 45, t. 1, f. 24 [forma]; Eichler in Pamietnik Fizyjogr. Warszawa, 1895, p. 59; Nordst. Index Desm. 1896, p. 72; Larsen, Freshw. Alg. E. Greenland, 1904, p. 83.

Ursinella Capitula Kuntze, Revis. gen. plant. 1891, p. 924.

Cells small, a little broader than long, very deeply constricted, sinus widely open outwards, but narrowed and almost acuminate at the apex; semicells elliptic-obsemicircular, lower part of lateral margins convex, apex convex, angles produced into stout rounded mamillæ with a slight upward direction. Side view of

semicell subcircular. Vertical view elliptic, with produced and submamillate poles, ratio of axes about 1 : 2·4. Cell-wall smooth.

Zygospore unknown.

Length 21 μ; breadth 23 μ; breadth of isthmus 7 μ [Messrs. Roy and Bissett's figure measures 5 μ]; thickness 9–9·4 μ.

Geogr. Distribution.—Galicia in Austria. Poland. East Greenland. Japan. Australia (var.).

The typical form of this species is not known to occur in the British Islands.

Var. **grœnlandicum** Börg. (Pl. LXXI, figs. 19–21.)

Cosmarium Capitulum Roy & Biss. var. *grœnlandicum* Börg. Ferskv. alg. Östgrönl. 1894, p. 16, t. 1, f. 5; Freshw. Alg. Færoës, 1901, p. 224; West & G. S. West, Scott. Freshw. Plankton, I. 1903, p. 541, t. 15, f. 5; Further Contrib. Freshw. Plankton Scott. Lochs, 1905, p. 500, t. 7, f. 2–3; Comp. Study Plankton Irish Lakes, 1906, p. 85.

Cells more robust with a broader isthmus; lower half of semicells more inflated and semicircular; mamillate angles slightly reduced; cell-wall punctate; vertical view broadly elliptic, with submamillate poles.

Length 19–31 μ; breadth 16·4–25 μ; breadth of isthmus 7·7–11·5 μ; thickness 11·3–16 μ.

Scotland.—In the plankton of Loch Morar, Inverness!, Lochs Cuthaig and Roinebhall, Lewis, Outer Hebrides!, and Loch Doon, Ayrshire!

Ireland.—In the plankton of a small lake between Clifden and Roundstone, Galway!, and in Lough Caragh, Kerry!

Geogr. Distribution.—Faeroes. Greenland.

We have only observed this variety in the Scottish and Irish plankton, in which it is sometimes not uncommon.

129. **Cosmarium Corribense** West & G. S. West. (Pl. LXXV, figs. 6–8.)

Cosmarium Corribense West & G. S. West, Comp. Study Plankton Irish Lakes, 1906, p. 101, t. 11, f. 20, 21.

Cells small, about as long as broad, fairly deeply

constricted, sinus widely open, either a little more or less than a right angle, with a slightly rounded apex; semicells cuneate, apex truncate and almost straight, superior angles rounded, sides slightly convex. Side view of semicell subcircular. Vertical view elliptic, poles obtusely conical, ratio of axes about 1 : 1·8. Cell-wall smooth. Chloroplasts axile, one in each semicell, with a central pyrenoid.

Zygospore unknown.

Length 22–24 μ; breadth 19–24 μ; breadth of isthmus 11·5–12 μ; thickness 12 μ.

Wales.—Plankton of Llyn Cwlyd, Carnarvonshire!

Ireland.—Plankton of Lough Corrib, Galway!

This species approaches very closely to *C. binucleatum* (Gay) Nordst., but it is much larger, the angles of the semicells are more rounded, and the thickness is much greater. It differs from *C. arctoum* var. *tatricum* Racib. in its larger size, its deeper constriction, and in the rounded angles of the semicells. (Consult the remarks on p. 43.)

It should also be compared with *C. subaversum* Borge and *C. subarctoum* (Lagerh.) Racib.

130. **Cosmarium quadratulum** (Gay) De Toni.

(Pl. LXXII, fig. 33; Pl. XCIII, fig. 4.)

Euastrum (*Cosmarium*) *quadratulum* Gay, Monogr. loc. Conj. 1884, p. 58, t. 1, f. 15.

Cosmarium quadratulum (Gay) De Toni, Syll. Alg. 1889, p. 934; Nordst. Index Desm. 1896, p. 216.

Ursinella quadratula Kuntze, Revis. gen. plant. 1891, p. 925.

Cells very small, a little longer than broad, deeply constricted, sinus narrowly linear with a slightly dilated apex; semicells transversely subrectangular, sides and apex slightly retuse, basal and upper angles obliquely truncate. Side view of semicell elliptic-circular. Vertical view elliptic, ratio of axes about 1 : 2. Cell-wall smooth. Chloroplasts axile, one in each semicell, with a central pyrenoid.

Zygospore unknown.

Length 12·5–15 μ; breadth 11–12·7; breadth of isthmus 2–3·4 μ; thickness 5·7–6·5 μ.

England.—Keighley Moor, W. Yorks!

Scotland.—Harris, Outer Hebrides!

Geogr. Distribution.—France. Galicia in Austria. Australia.

This small species is probably much more widely distributed than is indicated by the above records, as it is only very recently that we have realized its specific distinctness. It stands nearest to *C. Norimbergense* Reinsch, but is distinguished by its deeper constriction and by the obliquely truncate angles of the semicells. Owing to the latter character the semicells possess a very characteristic outline.

131. **Cosmarium subdanicum** West.

(Pl. LXXXV, figs. 25, 26.)

Cosmarium subdanicum West, Alg. W. Ireland, 1892, p. 150, t. 21, f. 4; Nordst. Index Desm. 1896, p. 245.

C. humile (Gay) Nordst. var. *subdanicum* (West) Schmidle, Beitr. alp. Alg. 1895, p. 389.

Cells very small, about as long as broad, very deeply constricted, sinus narrowly linear with a slightly dilated apex; semicells widely truncate-pyramidate, basal angles rectangular and retuse-emarginate, apical angles slightly rounded, sides very slightly convex and with a small emarginate wart in the middle, apex widely truncate and triundulate, centre of each semicell furnished with a small granule. Side view of semicell circular, with a small granule at the middle on each side. Vertical view elliptic, with a small granule at the middle on each side, ratio of axes about 1 : 1·6. Cell-wall smooth.

Zygospore unknown.

Length 16·4–17·5 μ; breadth 13·5–14 μ; breadth of isthmus 3–4 μ; thickness 8·2–8·5 μ.

Ireland.—Ballynahinch, Galway!

This small species has been regarded as one of the series of forms including *C. humile* (Gay) Nordst., *C. danicum* Börg., *C. striatum* Boldt., and *C. substriatum* Nordst., all of which are merely forms of *C. humile*. (Consult p. 221 *et seq.*) Schmidle has stated that *C. subdanicum* should be placed as *C. humile* var. *subdanicum*, but we think it quite distinct from *C. humile*

and nearer *C. Blyttii* Wille. It differs from the latter species chiefly in its smooth cell-wall, and to some extent in the lower parts of the sides of the semicells.

132. **Cosmarium zonatum** Lund.

(Pl. LXXVII, figs. 20, 21.)

Cosmarium zonatum Lund. Desm. Suec. 1871, p. 50, t. 3, f. 18; Lütkem. Desm. Attersees, 1893, p. 551; Nordst. Index Desm. 1896, p. 273; Schmidle, Lappmark Süsswasseralgen, 1898, p. 25; West & G. S. West, Freshw. Alg. Ceylon, 1902, p. 163.

Dysphinctium zonatum (Lund.) De Toni, Syll. Alg. 1889, p. 883.

Cells rather small, twice as long as broad, deeply constricted, sinus open and acute-angled; semicells subovate, gradually attenuated from a strongly convex base to a convex apex, sides slightly retuse. Side view of semicell ovate. Vertical view elliptic-circular. Cell-wall slightly thickened in the middle of each apex, smooth except for definite zones of punctulations; a simple series of punctulations immediately below each apex, one just above the middle of the semicells, a double series across the basal (widest) part of the semicells, and a few punctulations at the extreme base. Chloroplasts axile, one in each semicell, with a central pyrenoid.

Zygospore unknown.

Length 43·5–51 μ; breadth 22–26 μ; breadth of isthmus 7·5–11 μ; thickness 20–21 μ.

Scotland.—Rhiconich, Sutherland!

Geogr. Distribution.—Sweden. Austria. Ceylon. E. Africa (form).

This rare species is well characterized by the outward form of its cells and the zones (annular series) of delicate punctulations.

133. **Cosmarium binerve** Lund.

(Pl. LXXVII, fig. 22.)

? *Cosmarium quadratum* Hass. Brit. Freshw. Alg. 1845, p. 367, t. 86, f. 12.

C. binerve Lund. Desm. Suec. 1871, p. 49, t. 3, f. 15; Nordst. Index Desm. 1896, p. 61.

Dysphinctium binerve (Lund.) De Toni, Syll. Alg. 1891, p. 924.

Cells about of medium size, about twice as long as broad, deeply constricted, sinus narrowly linear with a slightly dilated apex; semicells truncate-pyramidate, lower and upper angles rounded (lower angles very slightly prominent), sides slightly retuse, apex slightly convex. Side view of semicell subelliptic, with two small ridges at and just below the apex, curving outwards and downwards. Vertical view circular, with two small curved ridges (or costæ) across the middle from side to side, convex towards each other. Cell-wall very delicately and densely striolate, with four transverse series of punctulations, two basal, one median, and one small apical series. Chloroplasts axile, one in each semicell, with a central pyrenoid.

Zygospore unknown.

Length 55–60 μ; breadth 30·5 μ; breadth of isthmus 10 μ; thickness 22 μ.

Geogr. Distribution.—Sweden.

This species should not, perhaps, be regarded as British, as the only evidence of a British specimen having been found is a very poor drawing in Hassal's 'British Freshwater Algæ' (1845) of a Desmid which that author imagined to be *C. quadratum*.

134. **Cosmarium Denotarisii** (Wittr.) Nordst.

(Pl. LXXXI, fig. 16.)

Cosmarium tetraophthalmum De Not. Desm. Ital. 1867, p. 38, t. 3, f. 19. [Not *C. tetrophthalmum* Bréb. 1848.]

C. tetraophthalmum Bréb. var. *De Notarisii* Wittr. Skandinav. Desm. 1869, p. 56.

C. De Notarisii (Wittr.) Nordst. Desm. Ital. 1876, p. 30; Roy & Biss. Scott. Desm. 1894, p. 100; Nordst. Index Desm. 1896, p. 99.

Cells large, about $1\frac{1}{3}$ times as long as broad, deeply constricted, sinus open and acute-angled, with a rounded apex; semicells elliptic-subsemicircular, dorsal margin much more convex than ventral margin. Side view of semicell broadly obovate-elliptic. Vertical view elliptic. Cell-wall densely and minutely scrobiculate, scrobiculations largely in concentric series. Chloroplasts . . . .?

Zygospore unknown.

Length 90–119 μ; breadth 68–75 μ; breadth of isthmus 27 μ; thickness 48 μ.

Scotland.—Falls of Connon, Ross; south of Portlethen, Kincardine; Fintray Hills, Stirling (*Roy & Bissett*).

Geogr. Distribution.—Italy. Sweden (Gotland).

We have not seen this species, but it appears to have a cell-wall like that of *C. pachydermum* Lund. Nordstedt has suggested (from an inspection of De Notaris's figures) that the chloroplasts are parietal.

135. **Cosmarium quadrimamillatum** West & G. S. West.

(Pl. XCIII, fig. 3.)

Cosmarium quadrimamillatum West & G. S. West, Notes Alg. III, 1903, p. 9 (sep.), t. 446, f. 12; Freshw. Alg. Orkneys and Shetlands, 1905, p. 22.

Cells small, about as long as broad or a little broader, deeply constricted, sinus narrowly linear with a dilated extremity; semicells transversely subrectangular or elliptic-rectangular, basal angles slightly rounded, sides subparallel or upwardly divergent, slightly concave, superior angles minutely but distinctly mamillate, apex broadly elevated and slightly subconvex, in the centre of each semicell with a single large granule, and with a smaller granule just within each mamilla. Side view of semicell subcircular, with a granule at the middle on each side. Vertical view elliptic, with a large median granule at each side, and a smaller granule at each side of the poles. Chloroplasts axile, one in each semicell, with a large central pyrenoid.

Zygospore unknown.

Length 23–27 μ; breadth 23–27·5 μ; breadth of isthmus 7–8·6 μ; thickness 13·5 μ.

England.—In ditches near the Lizard, Cornwall!

Scotland.—In a ditch, Bressay, Shetlands!

This species has so far only been observed from the west of Cornwall and from the Shetland Islands. It may be a western British type, but we have not succeeded in finding it either in the west of Ireland or in the Outer Hebrides.

Species to be Enquired into.

The four following *Cosmaria* are only imperfectly known. They were very briefly described by Archer, whose promised detailed information concerning them never appeared.

Cosmarium lasiosporum Arch. in Quart. Journ. Micr. Sci. xix, 1879, p. 123; Cooke, Brit. Desm. 1886, p. 92; De Toni, Syll. Alg. 1889, p. 46. *Ursinella lasiospora* Kuntze, Revis. gen. plant. 1891, p. 925. "Very minute (scarcely so large as *C. tinctum*). Sinus linear. Semicells flattened at the apex. Zygospore globose, beset with extremely minute, fine, and pointed spines." Size . . . . ?

Hab.—Ireland (in pools).

Cosmarium lobatosporum Arch. in Quart. Journ. Micr. Sci. vii, 1867, pp. 170–172; Rabenh. Flor. Europ. Alg. III, 1868, p. 179; Cooke, Brit. Desm. 1887, p. 121; De Toni, Syll. Alg. 1889, p. 1055. "Frond very minute, nearly twice as long as broad, general form elliptic; ends rounded, constriction an extremely shallow and very gentle narrowing. Zygospore rounded, somewhat irregularly lobed; lobes surmounted by one or two minute, pellucid, conical, and pointed spines or mucros; cell-wall reddish. Length 15 μ; breadth 10 μ; diam. zygosp. 25 μ."

Hab.—Ireland (in bog pools).

Cosmarium minutissimum Arch. in Quart. Journ. Micr. Sci. xvii, 1877, pp. 194 and 301; Cooke, Brit. Desm. 1886, p. 91. "Very minute, resembling *Sphærozosma excavatum*, but more minute, and with the sinus a narrow incision. Zygospore ellipsoidal or oblong, of a purplish or bronze-like hue, with thick walls." Size . . . . ?

Hab.—Ireland.

We observed a small *Cosmarium* in Welwitsch's collections from Angola, W. Africa, which we doubtfully referred to *C. minutissimum* Arch. (*vide* West & G. S. West, 'Welw. Afric. Freshw. Alg.' 1897, p. 120). We described it as follows:—"Very minute, about $1\frac{1}{4}$ times longer than broad, deeply constricted, sinus linear with a dilated extremity; semicells elliptic-semicircular. Side view of semicell subcircular.

Vertical view elliptic. Cell-wall colourless and smooth. Length 11 μ; breadth 8 μ; breadth of isthmus 2 μ; thickness 5 μ."

We have also referred a minute species of *Cosmarium* collected near Thirsk, N. Yorks., to Archer's species, but the identification is necessarily very uncertain (*vide* West & G. S. West, 'Alga-fl. Yorks.' 1900, p. 73). The semicells were somewhat flattened at the apex, and the zygospore was rhomboid-elliptic. Length 8·4 μ; breadth 8·5 μ; breadth of isthmus 2·7 μ; length of zygosp. 12 μ; breadth of zygosp. 10 μ.

Cosmarium Wrightianum Arch. in Ann. Mag. Nat. Hist. xi, 1883, p. 208; Cooke, Brit. Desm. 1887, p. 187. "Minute, smooth; semicells oblong-elliptic, ends somewhat retuse; but this feature is so slight as to be very readily overlooked." Zygospore "tetrahedral, the angles bluntly rounded." Size . . . .?

Hab.—Ireland.

Excluded Species.

Cosmarium platyisthmum Arch. in Ann. Mag. Nat. Hist. xi, 1883, p. 215; Cooke, Brit. Desm. 1887, p. 187; De Toni, Syll. Alg. 1889, p. 1034. *Ursinella platyisthma* Kuntze, Revis. gen. plant. 1891, p. 925. This Alga has recently been shown to belong to the Protococcaceæ (or Autosporaceæ) and should be known as Tetraëdron platyisthmum (*vide* G. S. West in 'Journ. Linn. Soc. bot.' xxxviii, 1908, pp. 286, 287, t. 21, f. 36–39).

Division II.—Cell-wall granulate, verrucose, or papillate.

[As in Division I (the smooth section of the genus) the arrangement of the species has been based on external form. We stated in vol. ii, p. 127, that this arrangement was an artificial one, and while admitting that it has the appearance of being somewhat arbitrary, the facilities it affords for the grouping of closely allied species cannot be over-estimated. We are gradually arriving at the conviction that external form is the dominating factor in the determination of the species-groups in Desmids ; and this being the case, much of the suggested artificiality of the present arrangement of *Cosmaria* disappears. In all large genera the arrangement of species *in sequence* can never more than approximately represent their relationship.]

Section A.—Semicells semicircular, subsemicircular, or semielliptical in outline; cells approximately circular, subcircular, or elliptical in outline.

* Constriction deep.

† Sinus open.

‡ Semicells with a basal tooth, granules confined to the margin.

136. *C. quadridentatum.*

‡‡ Semicells without a basal tooth, uniformly granulate.

137. *C. Corriense.*

138. *C. Simii.*

†† Sinus linear.

‡ Margin of semicells crenate.

139. *C. cælatum.*

‡‡ Margin of semicells entire.

§ Cells granulate.

140. *C. radiosum.*

141. *C. intermedium.*

§§ Cells with marginal papilliform granules.

142. *C. cristatum.*

§§§ Cells with marginal series of emarginate verrucæ.

143. *C. monomazum.*

144. *C. quadrifarium.*

** Constriction not very deep.

† Sinus acute; margin of semicells crenate.

145. *C. dovrense.*

†† Sinus a wide excavation; margin of semicells entire; cells granulate.

146. *C. isthmium.*

147. *C. excavatum.*

Section B.—Semicells circular or subcircular in outline.

* Constriction slight.

148. *C. subexcavatum.*

** Constriction fairly deep.

149. *C. orbiculatum.*

150. *C. prægrande.*

Section C. Semicells reniform, elliptical, subelliptical, or oblong-elliptical in outline.

* Semicells distinctly reniform in outline.

† Apices of cells produced. 151. *C. ornatum.*
152. *C. commisurale.*

†† Apices of cells not produced.
153. *C. dentiferum.*
154. *C. reniforme.*

** Semicells elliptical in outline, sinus linear.

† Cell-wall uniformly granulate, or nearly so.

‡ Margin of semicells entire.
155. *C. Turneri.*
156. *C. Brébissonii.*
157. *C. Logiense.*
158. *C. granulatum.*
159. *C. Portianum.*
160. *C. orthostichum.*
161. *C. solidum.*

‡‡ Margin of semicells undulate.
162. *C. Etchachanense.*
163. *C. Slewdrumense.*

†† Cell-wall not uniformly granulate; granules in the centre of the semicells differentiated and sometimes isolated.
164. *C. trachypleurum.*
165. *C. isthmochondrum.*
166. *C. jenisejense.*
167. *C. sphalerostichum.*
168. *C. geminatum.*

*** Semicells elliptical or oblong-elliptical in outline, sinus open.

† Cells large.

‡ Cell-wall finely granulate.
169. *C. trachydermum.*

‡‡ Cell-wall coarsely granulate.
170. *C. sphæroideum.*

†† Cells small. 171. *C. Wittrockii.*
172. *C. synthlibomenum.*

Section D. Semicells pyramidate or subpyramidate in outline, with the apex truncate.

* Cells as long as broad, or very slightly longer.

† Apex of semicells truncate and produced.

‡ Semicells with one central inflation.
173. *C. protractum.*
174. *C. Corbula.*
175. *C. Sportella.*
176. *C. vexatum.*
177. *C. Quassilus.*

‡‡ Semicells with two inflations near the centre.
178. *C. Turpinii.*

†† Apex of semicells truncate and not produced.

‡ Semicells with two inflations near the centre.
179. *C. didymoprotupsum.*

‡‡ Semicells somewhat widely truncate, without a central inflation.

§ Granules unequal in size and uneven in disposition.
180. *C. entochondrum.*
181. *C. Oligogongrus.*
182. *C. Ungerianum.*
183. *C. præmorsum.*

§§ Granules approximately equal in size, and more or less evenly distributed.
184. *C. margaritiferum.*
185. *C. quaternarium.*
186. *C. Arnellii.*
187. *C. furcatospermum.*

‡‡‡ Semicells with differentiated central granules and a slight indication of a central inflation.
188. *C. punctulatum.*
189. *C. anisochondrum.*
190. *C. bipunctatum.*
191. *C. bipapillatum.*
192. *C. distichum.*
193. *C. quinarium.*
194. *C. subtrinodulum.*

‡‡‡‡ Semicells with a distinct central inflation.

§ Margin not crenate.
195. *C. fastidiosum.*
196. *C. Kjellmani.*

§§ Margin either slightly or markedly crenate.

a Central protuberance small and somewhat papilliform.
197. *C. humile.*
198. *C. Blytii.*

β Central protuberance broader and granulate.
199. *C. sexnotatum.*
200. *C. subcrenatum.*
201. *C. subprotumidum.*
202. *C. Boeckii.*
203. *C. calcareum.*
204. *C. subcostatum.*
205. *C. costatum.*
206. *C. formosulum.*
207. *C. subreniforme.*
208. *C. pycnochondrum.*

** Cells $1\frac{1}{4}$ times longer than broad, or more.

† Margin of semicells crenate; crenations usually finely granulate.

‡ Marginal crenations numerous.

209. *C. pulcherrimum.*
210. *C. binum.*
211. *C. speciosum.*
212. *C. subspeciosum.*
213. *C. speciosissimum.*

‡‡ Marginal crenations few (not more than 12 in each semicell).

§ Cells hexagonal in outline.

a Semicells with 6 well-marked crenations.

214. *C. subalatum.*

β Semicells with about 12 crenations.

215. *C. hexalobum.*

§§ Cells elliptical, with subtruncate apices; semicells with about 8 crenations.

216. *C. nasutum.*

†† Margin of semicells undulate; granules small.

‡ Constriction deep, sinus linear.

217. *C. eductum.*
218. *C. didymochondrum.*
219. *C. subnotabile.*

‡‡ Constriction not deep, sinus open.

220. *C. tumens.*

††† Margin of semicells entire.

‡ Granules more or less restricted in their distribution on the semicells.

§ Cells small; semicells with retuse lateral margins; granules few and very restricted.

221. *C. retusum.*

§§ Cells very large; granules large and conical, confined to the marginal region.

222. *C. ovale.*

‡‡ Granules rounded and more or less uniformly distributed over the semicells.

§ Vertical view not tumid.

223. *C. Scoticum.*
224. *C. tetraophthalmum.*
225. *C. Botrytis.*
226. *C. Gayanum.*

§§ Vertical view tumid.

227. *C. controversum.*

‡‡‡ Granules flattened, somewhat irregular in outline, and often subdivided.

228. *C. ochthodes.*

Section E. Semicells more or less rectangular or subrectangular (rarely subpyramidate) in outline.

* Margin of semicells entire.

† Cells large or of medium size; cell-wall strongly granulate.

‡ Semicells transversely subrectangular; cells 1–1¼ times longer than broad.

§ Granules large; vertical view elliptic-oblong, not tumid.

229. *C. coronatum.*
230. *C. conspersum.*
231. *C. margaritatum.*
232. *C. quadrum.*
233. *C. Pseudobroomei.*

§§ Granules small; vertical view with a more or less marked protuberance on each side.

a Vertical view only slightly tumid.

234. *C. Subbroomei.*

β Vertical view strongly tumid.

235. *C. Broomei.*
236. *C. biretum.*

‡‡ Semicells elongate-rectangular; cells about twice as long as broad.

237. *C. amœnum.*
238. *C. pseudamœnum.*

†† Cells small; cell-wall finely granulate.

239. *C. latifrons.*
240. *C. lepidum.*

** Margin of semicells undulate or crenate.

241. *C. promontorium.*
242. *C. crenatum.*
243. *C. Grantii.*

Section F. Semicells subcylindrical; constriction of cells slight.

* Lateral margins of semicells subparallel; cell-wall with nodules in distinct zones.

244. *C. annulatum.*
245. *C. elegantissimum.*

** Lateral margins not parallel.

† Cell-wall granulate only at the apices of the semicells.

246. *C. tuberculatum.*

†† Cell-wall granulate over entire surface.

247. *C. cylindricum.*
248. *C. subcylindricum.*

136. **Cosmarium quadridentatum** West & G. S. West. (Pl. XCIII, fig. 5.)

Cosmarium quadridentatum West & G. S. West, Alg. N. Ireland, 1902, p. 36, t. 2, f. 11.

Cells small, a little longer than broad, deeply constricted, sinus sublinear, slightly open outwards, and a little dilated at the extremity; semicells trapeziform-semicircular, basal angles produced into a prominent acute tooth, sides slightly triundulate, apex broad and almost straight, with three indistinct granules within each lateral margin. Side view of semicell ovate from a broad base, apex truncately rounded. Vertical view elliptic, with acute poles, ratio of axes about 1 : 1·8. Cell-wall smooth except for the submarginal granules. Chloroplasts axile, one in each semicell, with a central pyrenoid.

Zygospore unknown.

Length 23·4–25 μ; breadth (with the basal teeth) 23–24 μ, without the teeth 21 μ; breadth of isthmus 8·5 μ; thickness 12 μ.

Ireland.—Loughs Fadda and Gatny, and near Lough Glentornan, Donegal!

This characteristic species occurred in abundance in Lough Gatny, but was somewhat scarce in the other localities.

137. **Cosmarium Corriense** Bissett. (Pl. LXXVI, fig. 1.)

Cosmarium Corriense Bissett in Roy & Biss. Scott. Desm. 1894, p. 44, t. 2, f. 6; Nordst. Index Desm. 1896, p. 84.

Cells rather under medium size, about $1\frac{1}{3}$ times as long as broad, with a fairly deep constriction, sinus somewhat linear but open along its entire length; semicells trapeziform-semicircular, basal angles rectangular and scarcely rounded, upper angles broadly rounded. Cell-wall finely granulate, granules arranged in about 11 vertical series, about 22 showing along the margin of each semicell. Side view of semicell

subcircular. Vertical view elliptic, ratio of axes about 1 : 1·5.

Zygospore unknown.

Length 43 μ; breadth 32 μ; breadth of isthmus 15 μ; thickness 21 μ.

Scotland.—In a quarry, at Corrie, Arran (*Bissett*).

Ireland.—Carrantuohill, Kerry !

This species should be compared with *C. Portianum*, from which it is distinguished by the rectangular lower part of the semicells.

138. **Cosmarium Simii** Roy & Biss.

(Pl. LXXVI, fig. 2.)

Cosmarium Simii Roy & Biss. Scott. Desm. 1894, p. 174, t. 2, f. 16; Nordst. Index Desm. 1896, p. 234.

Cells of medium size, about $1\frac{1}{6}$ times longer than broad, deeply constricted, sinus widely open and acute-angled; semicells subsemicircular from a convex base, basal angles slightly subrectangular. Cell-wall somewhat finely granulate, granules arranged in about 15 or 16 vertical rows and about 7 transverse arched rows, about 25 showing along the margin of each semicell. Vertical view elliptic.

Zygospore unknown.

Length 53–58 μ; breadth 45–50 μ; breadth of isthmus 20–22 μ.

Scotland.—Very rare in Corrie Etchachan on Ben Macdhui, Aberdeen (*Roy & Bissett*).

Compare with *C. Corriense* and *C. reniforme*.

139. **Cosmarium cælatum** Ralfs.

(Pl. LXXVI, figs. 5–7.)

Cosmarium cælatum Ralfs, Brit. Desm. 1848, p. 103, t. 17, f. 1; Arch. in Pritch. Infus. 1861, p. 734, t. 2, f. 26; Rabenh. Flor. Europ. Alg. III, 1868, p. 170; Lund. Desm. Suec. 1871, p. 33; Nordst. Norges Desm. 1873, p. 14; Kirchn. Alg. Schles. 1878, p. 154; Wolle, Desm. U. S. 1884, p. 86, t. 18, f. 46–48 [figures poor]; Cooke, Brit. Desm. 1887, p. 111, t. 40, f. 3; Hansg. Prodr. Algenfl. Böhm. 1888, p. 202; De Toni, Syll. Alg. 1889, p. 1007; West, Alg. N. Wales, 1890, p. 290; Heimerl, Desm. alpin. 1891, p. 595; West, Alg. W. Ireland, 1892, p. 158; Alg. Engl.

Lake Distr. 1892, p. 728; Schmidle, Beitr. Algenfl. Schwarzwald. u. Rheineb. 1893, p. 102; Roy & Biss. Scott. Desm. 1894, p. 44; Borge, Süssw. Chlor. Archang. 1894, p. 29; Nordst. Index Desm. 1896, p. 70; West & G. S. West, Alg. S. England, 1897, p. 491; Schmidle, Lappmark Süsswasseralgen, 1898, p. 38; West & G. S. West, Alga-fl. Yorks. 1900, p. 70; Börg. Freshw. Alg. Faeroës, 1901, p. 226; West & G. S. West, Alg. N. Ireland, 1902, p. 40; Larsen, Freshw. Alg. E. Greenland, 1904, p. 83; West & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 18; Borge, Beiträge Alg. Schweden, 1906, p. 41.

Euastrum (*Cosmarium*) *decorum* Gay, Monogr. loc. Conj. 1884, p. 62, t. 2, f. 3.

Cosmarium decorum (Gay) De Toni, Syll. Alg. 1889, p. 968.

Ursinella cælata Kuntze, Revis. gen. plant. 1891, p. 924.

U. decora Kuntze, l. c. p. 924.

Cosmarium Westianum Benn. Freshw. Alg. S. W. Surrey, 1892, p. 11, t. 2, f. 14 [figure very bad].

Cells somewhat small, about as long as broad or a little longer, deeply constricted, sinus narrowly linear with a slightly dilated apex; semicells subsemicircular, margin strongly crenate, two lateral and four apical, lower lateral crenæ larger than others and somewhat flattened, crenæ granulate, apical and upper lateral crenæ with 2 (sometimes 3) marginal granules, lower lateral crenæ with 4 marginal granules; within the margin with about three irregular series of granules gradually diminishing in number away from the periphery; lower part of semicells above the isthmus furnished with a number of prominent granules, covering a wide protuberance, and usually disposed in rather irregular vertical series. Side view of semicell broadly ovate-pyramidate, upper portions of lateral margins slightly retuse, apex emarginate with rounded angles. Vertical view elliptic with a broad inflation at each side, slightly retuse below the poles, which are rounded; granulation of margin almost even.

Zygospore unknown.

Length 40–47 μ; breadth 36–40 μ; breadth of isthmus 12–14 μ; thickness 24–26 μ.

England.—Cumberland! Westmoreland! (*Bissett*). Lancashire! W., N., & E. Yorks! Leicestershire (*Roy*). Essex! Sussex (*Ralfs*). Kent! Wilts! Devon! Cornwall! (*Marquand*).

Wales.—General! (At 2200 ft. on Glyder Fach, Carnarvonshire.)

Scotland. — Common! (*Roy & Bissett*). Outer Hebrides! Shetlands!

Ireland. — Donegal! Mayo! Galway! Kerry! Dublin and Wicklow (*Archer*). Down (up to 2000 ft.)!

Geogr. Distribution.—France. Belgium. Germany. Austria and Galicia. Norway. Sweden. Bornholm (var.). Finland. N. Russia (form). S. Russia. Faeroes. Azores. United States.

C. cælatum is one of the most characteristic species of the genus. It is principally an upland species, where it is not infrequently found on wet rocks, but it is not a true alpine Desmid. On old heaths and commons, which are still parts of the primitive country, it often occurs in boggy springs. In such situations it is usually found among large numbers of Diatoms.

The marginal granules are acute, but the basal ones are rounded. Considerable variation is shown in the disposition of the granules on the broad basal tumour.

Var. **spectabile** (De Not.) Nordst. (Pl. LXXVI, fig. 8.)

Cosmarium spectabile De Not. Desm. Ital. 1867, p. 45, t. 4, f. 31; Rabenh. Flor. Europ. Alg. III, 1868, p. 170.

Euastrum (*Cosmarium*) *spectabile* (De Not.) Gay, Monogr. loc. Conj. 1884, p. 62.

Cosmarium cælatum Ralfs var. *spectabile* (De Not.) Nordst. Desm. Ital. 1876, p. 40; De Toni, Syll. Alg. 1889, p. 1008; Lütkemüll. Desm. Attersees, 1893, p. 555, t. 8, f. 8 (?); Roy & Biss. Scott. Desm. 1894, p. 44; Lütkem. Desm. Millstättersees, 1900, p. 8; Borge, Beiträge Alg. Schweden, 1906, p. 41.

Scarcely to be distinguished from the typical form except by its slightly greater angularity and by the more band-like disposition of the granules across the base of the semicells.

Length 39–46·5 μ; breadth 35–40 μ; breadth of isthmus 15–16 μ; thickness 21–22 μ.

Wales. — Snowdon! and Capel Curig! (*Roy*), Carnarvonshire.

Scotland.—Frequent (*Roy & Bissett*).

Geogr. Distribution.—France. Italy. Austria and Galicia. Sweden.

It seems scarcely possible to separate any form of *C. cælatum* under the varietal name "*spectabile*." The figure we give was taken from a Carnarvonshire specimen which more nearly approached De Notaris's figure than any other specimen we have seen. The basal granulation of the semicells is in the form of a broad transverse band of short, almost vertical series, with from three to four granules in a series. The figure given by Dr. Lütkemüller ('Desm. Attersees,' t. 8, f. 8) does not appear to us to belong to this variety, as it does not possess the arrangement of the basal granules which constitutes the sole distinguishing feature of var. *spectabile*.

Var. **hexagonum** West. (Pl. LXXVI, fig. 9.)

Cosmarium cælatum Ralfs var. *hexagonum* West, Alg. N. Wales, 1890, p. 290, t. 6, f. 30.

Cells subrectangular-hexagonal, apex truncate; the two lateral crenæ of each semicell approximately equal in size; granules of broad basal inflation arranged in transverse and vertical series.

Length 43–45 μ; breadth 36–38 μ; breadth of isthmus 10–11 μ; thickness 25–26 μ.

Wales.—Capel Curig, Carnarvonshire!

Geogr. Distribution.—Germany.

140. **Cosmarium radiosum** Wolle.

(Pl. LXXVI, figs. 3, 4.)

Cosmarium radiosum Wolle, Desm. U. S. 1884, p. 90, t. 19, f. 21–22; De Toni, Syll. Alg. 1889, p. 1052; West, Alg. W. Ireland, 1892, p. 159; Nordst. Index Desm. 1896, p. 220.
Ursinella radiosa Kuntze, Revis. gen. plant. 1891, p. 925.

Cells of medium size, $1\frac{1}{8}$–$1\frac{1}{5}$ times as long as broad, deeply constricted, sinus narrowly linear with a slightly dilated extremity; semicells pyramidate-semicircular, sides strongly convex, apex subtruncate or truncately rounded, basal angles rounded; cell-wall finely granulate, granules in radiating and concentric series, about 30–35 showing at the margin, and 6 or 7 in each radial row, gradually diminishing in size from the periphery towards the centre, median basal part of semicell with 8 or 9 subvertical (somewhat diver-

gent) series of granules, 6 or 7 in each series, and gradually becoming reduced in size from the base upwards. Side view of semicell oblong-rectangular, slightly tumid at the base on each side, apex subtruncate. Vertical view elliptic with a slight central inflation.

Zygospore unknown.

Length 55–58 μ; breadth 45–50 μ; breadth of isthmus 12 μ; thickness 23 μ.

Ireland.—Creggan Lough, Galway!

Geogr. Distribution.—United States.

This species should be compared with some forms of *C. Botrytis*, from which it is distinguished by its slightly smaller size and the different granulation.

141. **Cosmarium intermedium** Delp.

(Pl. LXXVI, fig. 10.)

Cosmarium intermedium Delp. Desm. subalp. 1877, p. 25, t. 8, f. 7–10; De Toni, Syll. Alg. 1889, p. 996; Roy & Biss. Scott. Desm. 1894, p. 104; Nordst. Index Desm. 1896, p. 148.
Ursinella intermedia Kuntze, Revis. gen. plant. 1891, p. 925.

Cells of medium size, about $1\frac{1}{4}$ times as long as broad, deeply constricted, sinus narrowly linear with a dilated extremity; semicells somewhat pyramidate-semicircular with a broadly rounded apex, basal angles rounded. Side view of semicell angular-ovate, lower parts of sides upwardly divergent, upper parts convergent, apex rounded. Vertical view elliptic, ratio of axes 1 : 2. Cell-wall uniformly granulate; granules rounded, arranged in concentric series. Chloroplasts axile (?), with two pyrenoids.

Zygospore unknown.

Length 79 μ; breadth 61 μ; breadth of isthmus 19 μ; thickness 28 μ.

Scotland.—Near Portree in Skye, Inverness; near Aboyne, Aberdeen; near Tobermory in Mull, Argyll (*Roy & Bissett*).

Geogr. Distribution.—Germany (form). Italy. United States (?).

We have never seen any *Cosmarium* which we could identify with certainty as *C. intermedium* Delp. It appears to be very closely related to, if not a form of *C. Botrytis*, and we have reason to doubt the accuracy of Delponte's figures. The granulation of many of Delponte's figures has undoubtedly been inserted without any careful reference to the specimens.

142. **Cosmarium cristatum** Ralfs.

(Pl. LXXVI, fig. 11.)

Cosmarium cristatum Ralfs, Brit. Desm. 1848, p. 105, t. 17, f. 2; Arch. in Pritch. Infus. 1861, p. 734, t. 1, f. 4; Rabenh. Flor. Europ. Alg. III, 1868, p. 172; Cooke, Brit. Desm. 1887, p. 114, t. 40, f. 6; De Toni, Syll. Alg. 1889, p. 1051; West, Alg. N. Wales, 1890, p. 290; Roy & Biss Scott. Desm. 1894, p. 44; Nordst. Index Desm. 1896, p. 89; West & G. S. West, Alg. S. England, 1897, p. 491.
Ursinella cristata Kuntze, Revis. gen. plant. 1891, p. 924.

Cells small, very little longer than broad, deeply constricted, sinus narrow and linear, but not quite closed; semicells almost semicircular, basal angles not rounded, margin furnished with 14–16 short and equidistant papillæ, centre of semicell with a protuberance ornamented with a circlet of 8 granules surrounding one central granule. Vertical view narrowly oblong, with subtruncate poles, at the middle on each side with a broad protuberance showing about 4 granules.

Zygospore unknown.

Length 36–37 μ; breadth 34·5–36 μ; breadth of isthmus 10–10·5 μ; thickness 15·5 μ.

England.—Near Ambleside, Westmoreland (*Ralfs*). Furness Fells and Wetherlam, Lancashire (*Bennett*). Thursley Common, Surrey! Cornwall (*Bennett*).

Wales.—Capel Curig, Carnarvonshire!

Scotland.—Glen Tanner, Aberdeen; Cammie, Kincardine (*Roy & Bissett*). Ben Lawers, Perth!

Ireland.—Derryclare Lough, Galway! Castletown, Kerry! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Hungary.

This characteristic species appears to be exceedingly rare. We have only met with it five times, and on each occasion a solitary specimen only was observed.

143. **Cosmarium monomazum** Lund.
(Pl. LXXVI, fig. 12.)

Cosmarium monomazum Lund. Desm. Suec. 1871, p. 32, t. 3, f. 11; Cooke, Brit. Desm. 1887, p. 99, t. 37, f. 19; De Toni, Syll. Alg. 1889, p. 1015; West, Alg. Engl. Lake Distr. 1892, p. 726; Nordst. Index Desm. 1896, p. 175; West & G. S. West, Alga-fl. Yorks. 1900, p. 69.
Ursinella monomaza Kuntze, Revis. gen. plant. 1891, p. 925.

Cells somewhat small, about as long as broad, deeply constricted, sinus narrowly linear; semicells subsemicircular from an angular base, basal angles rounded but somewhat obliquely truncate, with a minute tooth at the entrance to the sinus, apex slightly flattened, margin of semicell furnished with about 16 very slightly emarginate flattened warts, centre of semicell with a single large granule. Side view of semicell circular, with a large granule at the middle on each side and on each side of the apex, and with two diverging series of emarginate warts extending from the base upwards to the apical granules. Vertical view elliptic, with subtruncate poles, ratio of axes about 1 : 1·5, with a large granule at the middle on each side and a smaller one at each side of the poles, and with a series of emarginate warts extending from pole to pole just within each lateral margin.

Zygospore unknown.

Length 38 μ; breadth 34 μ; breadth of isthmus 11·5 μ; thickness 22 μ.

England.—Blea Tarn, Westmoreland! Penyghent, W. Yorks!

Geogr. Distribution.—Saxony (var.). Sweden. United States (var.).

Var. **polymazum** Nordst. (Pl. LXXVI, figs. 13, 14.)

C. monomazum Lund. var. *polymazum* Nordst. Norges Desm. 1873, p. 14, t. 1, f. 3; West, Alg. W. Ireland, 1892, p. 151; Roy & Biss. Scott. Desm. 1894, p. 169; Nordst. Index Desm. 1896, p. 175; West & G. S. West, Alga-fl. Yorks. 1900, p. 70; Alg. N. Ireland, 1902, p. 38.
C. polymazum (Nordst.) Wolle, Desm. U. S. 1884, p. 70, t. 16, f. 38–40.

Semicells with the basal angles more rounded, and with 16–20 flat emarginate warts immediately within the margin; with three large granules (the middle one

sometimes extra large) forming a transverse series across the middle of the semicell, and one large granule immediately above the isthmus.

Length 32–39 μ; breadth 32–39 μ; breadth of isthmus 9–14 μ; thickness 18–24 μ.

England.—Near Bowness, Westmoreland (*Bissett*).

Scotland.—Rhiconich, Sutherland! Near View Rock, Strathpeffer, Ross (*Roy & Bissett*).

Ireland.—Near Glenties, Donegal! Ballynahinch, Galway!

Geogr. Distribution.—Norway. United States.

In Europe this variety has essentially a western and north-western distribution, and appears to be confined to the old formations. Turner's record from "Gormire, N. Yorks." is very doubtful and requires further confirmation.

An American variety of *C. monomazum* (var. *tristichum* W. & G. S. West, 'Some Desm. U. S.' 1898, p. 305, c. fig.) possesses 9 central granules in three transverse series.

144. **Cosmarium quadrifarium** Lund.

(Pl. LXXVI, figs. 15–17; Pl. LXXVII, figs. 1–3.)

Cosmarium quadrifarium Lund. Desm. Suec. 1871, p. 32, t. 3, f. 12; Wolle, Desm. U. S. 1884, p. 87, t. 17, f. 16–18; Cooke, Brit. Desm. 1887, p. 115, t. 40, f. 8; Boldt, Desmid. Grönland, 1888, p. 23; De Toni, Syll. Alg. 1889, p. 1022; West, Alg. W. Ireland, 1892, p. 158; Roy & Biss. Scott. Desm. 1894, p. 173; Nordst. Index Desm. 1896, p. 218; Schmidle, Lappmark Süsswasseralgen, 1898, p. 39; Borge, Beiträge Alg. Schweden, 1906, p. 42.

Ursinella quadrifaria Kuntze, Revis. gen. plant. 1891, p. 925.

Cosmarium quadrifarium forma *stellata* Gutw. Alg. Ins. Java, 1902, p. 596, t. 38, f. 46.

Cells rather under medium size, about $1\frac{1}{4}$ times longer than broad, deeply constricted, sinus narrowly linear with a slightly dilated apex; semicells semicircular, basal angles subrectangular and only a little rounded, margin furnished with 15–17 truncate-emarginate warts, those at the basal angles commonly slightly reduced, with a similar series of emarginate warts immediately within the margin; in the basal part of the semicells just above the isthmus with a prominent rounded tumour ornamented with 12–17

rounded granules, which vary considerably in disposition, and sometimes with minute intergranular scrobiculations. Side view of semicell ovate, upper parts of sides retuse, apex subtruncate, basal tumours with 4 marginal granules, apex 4-granulate, and with a band of emarginate warts in 4 parallel series extending from just above the isthmus to the apex. Vertical view elliptic, ratio of axes about 1 : 1·5, poles subtruncate and furnished with 4 granules, with a broad tumour (4-granulate) at the middle on each side, and with 4 parallel series of emarginate warts extending from pole to pole. Cell-wall often minutely punctate. Chloroplasts axile, with two pyrenoids.

Zygospore quadrate-rectangular and smooth, angles a little produced, rounded or subtruncate (rarely retuse), sides straight or slightly convex; the two angles of one end of the zygospore sometimes twisted into a plane at right angles to that containing the other two.

Length 40–57·5 μ; breadth 32–39 μ; breadth of isthmus 10–16 μ; thickness 20–26·4 μ; length of zygosp. 40–48 μ; breadth of zygosp. 34–36 μ.

Wales.—Capel Curig!, Glyder Fawr (*Roy*), and Llyn-y-cwm-ffynon!, Carnarvonshire.

Scotland.—Rhiconich, Sutherland! Skye, Glen Nevis, and Invermoidart, Inverness! Near Longside, Aberdeen; Glencoe, Argyll; Goat Fell and Glen Ranga, Arran (*Roy & Bissett*). Common in the Outer Hebrides (zygospores from near Tarbert, Harris)!

Ireland.—Kylemore and Ballynahinch, Galway! Adrigole, Castletown, and Carrantuohill, Kerry!

Geogr. Distribution.—Saxony. Norway. Sweden. Greenland. Ceylon. Java (form). New Zealand. United States. Brazil (var.). Patagonia.

C. quadrifarium often occurs associated with *C. monomazum* var. *polymazum*, and, like that Desmid, it appears to have a western and north-western British distribution. It is a very characteristic species, with an equally characteristic zygospore, although it shows a considerable variation in the details of arrangement of the central granules, and in the number

of marginal verrucæ. In some parts of Sutherland and the Outer Hebrides it is quite common.

The smallest recorded form (forma *minor*) is from Ceylon: length 34·5–37 μ; breadth 23–26 μ (*vide* W. & G. S. West, 'Freshw. Alg. Ceylon,' 1902, p. 171).

Forma **hexasticha** (Lund.) Nordst. (Pl. LXXVII, fig. 4.)

Cosmarium hexastichum Lund. Desm. Suec. 1871, p. 33, t. 3, f. 13; Nordst. Norges Desm. 1873, p. 14; Nordst. Desm. Grönl. 1885, p. 9; Cooke, Brit. Desm. 1887, p. 115, t. 40, f. 9; De Toni, Syll. Alg. 1889, p. 1023; Roy & Biss. Scott. Desm. 1894, p. 103.

C. quadrifarium forma *hexasticha* (Lund.) Nordst. Freshw. Alg. N. Zeal. 1888, p. 49; West, Alg. N. Yorks, 1889, p. 293; Alg. W. Ireland, 1892, p. 158; Schmidle, Lappmark Süsswasseralgen, 1898, p. 39; West & G. S. West, Alga-fl. Yorks. 1900, p. 70; Borge, Alg. erst. Regnell. Exped. II, Desmid. 1903, p. 100.

Ursinella hexasticha Kuntze, Revis. gen. plant. 1891, p. 924.

Semicells with 6 parallel series of emarginate verrucæ in the marginal region, two series usually visible within the marginal warts; central granules variable, commonly similar to those of the type, but sometimes in 4 transverse series. Poles of side and vertical views with 6 granules.

Length 40–53 μ; breadth 32–44 μ; breadth of isthmus 14–21 μ; thickness 21–31 μ.

England.—Mickle Fell, N. Yorks!

Wales.—Capel Curig and Llyn-y-cwm-ffynon, Carnarvonshire!

Ireland.—Ballynahinch, Galway! Adrigole, Kerry!

Geogr. Distribution.—Germany. Norway. Sweden. Greenland. Siam. Australia. New Zealand. Brazil (form).

In the British Islands this form is much rarer than the one with only four marginal series of truncate-emarginate warts.

Forma **octasticha** Nordst.

C. hexastichum var. *octastichum* Nordst. Norges. Desm. p. 14; Boldt, Desmid. Grönland. 1888, p. 23; Roy & Biss. Scott. Desm. 1894, p. 103.

C. quadrifarium forma *octasticha* Nordst. Freshw. Alg. N. Zeal. 1888, p. 49.

Semicells with 8 parallel series of emarginate warts

in the marginal region; inner series often somewhat reduced.

Length 52–57·6 μ; breadth 40–45·6 μ; breadth of isthmus 17–20·4 μ; thickness 25–28·8 μ.

Scotland.—Loch Ruthven, Inverness (*Roy & Bissett*).

Geogr. Distribution.—Norway. Greenland.

Forma **polysticha** *nob.* (Pl. XCI, fig. 12.)

C. hexastichum var. *polystichum* Boldt, Desmid. Grönland, 1888, p. 23.
C. supraspeciosum Wolle var. *emarginatum* West, Alg. Engl. Lake Distr. 1892, p. 729, t. 9, f. 24.

Semicells with 10 or more parallel series of emarginate warts in the marginal region; inner two series much reduced; number of warts in each series 18–27. Poles of vertical and side views with 10 or more granules.

Length 55·2–61 μ; breadth 45·6–52 μ; breadth of isthmus 18–20·4 μ.

England.—Brothers' Water, Westmoreland!

Geogr. Distribution.—Greenland.

145. **Cosmarium dovrense** Nordst. (Pl. LXXVII, figs. 5, 6.)

? *Euastrum crenatum* Perty Kleinst. Lebensf. 1852, p. 209, t. 16, f. 10.
Cosmarium crenatum var. *subcrenatum* Rabenh. Flor. Europ. Alg. III, 1868, p. 165.
Cosmarium dovrense Nordst. in Wittr. & Nordst. Alg. Exsic. 1879, no. 255; fasc. 21, p. 40; De Toni, Syll. Alg. 1889, p. 947; Racib. Desm. Nowe, 1889, p. 81, t. 5, f. 38; Lütkem. Desm. Attersees, 1893, p. 555; Nordst. Index Desm. 1896, p. 112; West & G. S. West, Alga-fl. Yorks. 1900, p. 70.
C. Pertyanum Racib. Nonn. Desm. Polon. 1885, p. 77.
Ursinella dovrensis Kuntze, Revis. gen. plant. 1891, p. 924.

Cells somewhat small, about 1½ times as long as broad, moderately constricted, sinus somewhat linear, but not closed; semicells semi-elliptic (or subsemicircular), about two-thirds of the circumference of a circle, sometimes a little narrowed at the base, basal angles subrectangular but rounded, margin 8-crenate (or undulate-crenate), rarely 10-crenate, crenæ 2–4-granulate,

granules minute, within the crenate margin furnished with minute granules, often disposed in pairs or in threes, more or less concentrically and radiately arranged, with 12–15 short vertical ridges across the base of the semicell, each ridge 2–4-granulate, area immediately above this basal zone smooth. Side view of semicell sub-ovate, slightly tumid at the base on each side, upper half broadly rounded and 10–12-undulate. Vertical view broadly elliptic, with somewhat pointed poles, ratio of axes 1 : 1·4, each side with 12–15 granules. Chloroplasts axile, one in each semicell, with a central pyrenoid.

Zygospore unknown.

Length 35–42 μ; breadth 23–29 μ; breadth of isthmus 14–20 μ; thickness 23–26 μ.

England.—Near Cowside Beck, Arncliffe, and in Heseltine Ghyll on Penyghent, W. Yorks!

Geogr. Distribution.—Norway. Austria. Poland.

This characteristic species was originally described by Nordstedt from Norway, where it was found among mosses on wet mountain rocks. We have only found it on vertical dripping faces of limestone rocks in the Pennine Chain, and several times in pure masses.

146. **Cosmarium isthmium** West.

(Pl. LXXVII, figs. 7–10; Pl. XCIV, fig. 2.)

Cosmarium excavatum Nordst. forma *duplo-major* Wolle, Desm. U. S. 1884, p. 77, t. 53, f. 14, 15 [not Lundell, 1871].

C. isthmium West, Alg. N. Wales, 1890, p. 290, t. 5, f. 19; Alg. Engl. Lake Distr. 1892, p. 729; Nordst. Index Desm. 1896, p. 149; West & G. S. West, Alg. S. England, 1897, p. 491.

Cells rather small, rather more than $1\frac{1}{2}$ times as long as broad, fairly deeply constricted, sinus widely open, forming a semicircular or semi-elliptic excavation; semicells semicircular, basal angles subrectangular and not rounded, cell-wall ornamented with rounded granules arranged in 8–10 vertical series, about 7 granules in each series, slightly reduced at the apex and 16–20 granules showing at the margin. Vertical view almost circular (very slightly compressed), with

about 27–28 granules visible at the margin. Chloroplasts axile, one in each semicell, with a prominent central pyrenoid.

Zygospore broadly ellipsoid, furnished with numerous short, truncate or slightly emarginate processes, about 15 of which are visible round the periphery.

Length 40–48 μ; breadth 25–28 μ; breadth of isthmus 11–13·5 μ; length of zygosp. with processes 41–43 μ, breadth 30–37 μ, length of processes 4–5 μ.

England.—Bowness and Loughrigg, Westmoreland! Puttenham Common, Surrey!

Wales.—Capel Curig, Carnarvonshire!

Scotland.—Rhiconich, Sutherland!

Geogr. Distribution.—United States.

C. isthmium is a well-marked species of very rare occurrence. It is one of the western British types which are almost entirely confined to the very rich places on the old formations, where it is found in association with *C. monomazum* var. *polymazum* and *C. quadrifarium*. It differs from *C. excavatum* Nordst. in its larger size, its deeper constriction and less open sinus, and in its more numerous granules. The latter are disposed in vertical series, and they are generally slightly reduced in size at the apices. We have examined the zygospores of this species from near Orono, Maine, U.S.A.

C. isthmium is of about the same size as *C. Portianum*, but is at once distinguished by the form of its semicells and by the excavated sinus, as well as by the almost circular vertical view. The zygospore also differs in the possession of emarginate processes.

Forma **hibernica** West. (Pl. LXXVII, fig. 11.)

C. isthmium forma *hibernica* West, Alg. W. Ireland, 1892, p. 159, t. 21, f. 15 [figures very poor].

Cells larger, constriction less deep and isthmus wider, inferior angles of semicells slightly rounded; granules not so regularly arranged, and often scattered.

Length 50–56 μ; breadth 31–35 μ; breadth of isthmus 19–22 μ.

Ireland.—Ballynahinch, Galway! Sugar Loaf Mt., Castletown, and Glengarriff, Kerry!

We have only observed this large form from the west of Ireland. The broad isthmus, slightly rounded basal angles, and the more irregular disposition of the granules are its principal features. As in the type the vertical view is almost circular.

The Desmid described as "*C. isthmium* West var. *horizontale* Schmidle" ('Lappmark Süsswasseralgen,' 1898, p. 31, t. 1, f. 40) is most likely a form of *Cosmarium subexcavatum* with regularly disposed granules.

147. **Cosmarium excavatum** Nordst.

(Pl. LXXVII, fig. 12.)

Cosmarium excavatum Nordst. Desm. Brasil. 1870, p. 214, t. 3, f. 25; Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 47; Roy & Biss. Scott. Desm. 1894, p. 101; Nordst. Index Desm. 1896, p. 121.

Dysphinctium? excavatum (Nordst.) De Toni, Syll. Alg. 1889, p. 884.

Cells small, almost twice as long as broad, slightly constricted, sinus a very wide and shallow depression, isthmus much elongated; semicells subsemicircular, cell-wall granulate, margin about 9-granulate (or subundulate), within the margin with rather few and somewhat sparsely (subconcentrically) disposed granules. Vertical view circular, granulate, with about 17 peripheral granules.

Zygospore unknown.

Length 19 μ; breadth 10–10·5 μ; breadth of isthmus 7·5 μ.

Scotland.—Aberdeen, Kincardine, Forfar (*Roy & Bissett*).

Ireland.—Dublin and Wicklow (*Archer*).

Geogr. Distribution.—Norway. Sweden. Nova Zembla. Greenland. Japan. New Zealand. United States. Brazil. Paraguay.

We have never examined any Desmid which we could refer to the typical form of this species, and we suspect that the records of Messrs. Roy and Bissett really refer either to the "forma *duplo-major*" or to *C. isthmium*.

C. excavatum Nordst. var. *trigonum* Lagerh., described from Georgia, U.S.A. (*vide* Lagerh. Bidr. Amerik. Desm.-fl. 1885, p. 236, t. 27, f. 7), is very possibly a species of the genus *Staurastrum*.

Forma **duplo-major** Lund. (Pl. XCIV, fig. 3.)

C. excavatum Nordst. forma duplo-major Lund. Desm. Suec. 1871, p. 46; Wille, Ferskv. Alg. Nov. Semlja, 1879, p. 47.

Cells twice the size of the typical form.

Length 39–42·5 μ; breadth 21·5–25 μ; breadth of isthmus 15–17 μ.

Wales.—Capel Curig, Carnarvonshire!

Geogr. Distribution.—Sweden. Nova Zembla.

Except for its much larger size this form agrees very closely with the original Brazilian *C. excavatum*. It is of the same length as *C. isthmium*, but differs from that Desmid in its proportionately narrower cells, its shallower constriction, its broader isthmus, and in the disposition of its granules.

148. **Cosmarium subexcavatum** West & G. S. West. (Pl. LXXVII, fig. 13.)

Cosmarium excavatum Nordst. var. *ellipticum* Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 47, t. 13, f. 46; ? Boldt, Desm. Grönland, 1888, p. 28; Börg. Ferskv. Alg. Ostgrönl. 1894, p. 15.

C. excavatum Nordst. forma *major* Boldt, Desm. Grönland, 1888, p. 28, t. 2, f. 30.

C. isthmium West var. *Willei* West, Alg. W. Ireland, 1892, p. 160.

Dysphinctium Willei Schmidle, Alg. Bern. Alp. 1894, p. 94.

Cosmarium subexcavatum West & G. S. West, Notes Alg. II, 1900, p. 293.

C. Willeanum Migula in Flora von Deutschland, Österreich und der Schweiz. Bd. 5 (Desmidiaceæ in parts 29–36), 1906, p. 454, t. 23 N, f. 7. [Not *C. Willeanum* Racib., 1892.]

Cells small, about $1\frac{2}{5}$ times as long as broad, moderately constricted, sinus open and subrectangular; semicells subcircular (periphery about $\frac{2}{3}$ to $\frac{3}{4}$ of a circle), cell-wall granulate, granules densely arranged in longitudinal series [according to Wille's brief description], 15–16 showing at the margin. Vertical view circular or circular-elliptic. Chloroplasts axile, one in each semicell, with a central pyrenoid.

Zygospore unknown.

Length 28·8–29 μ; breadth 19·2–23 μ; breadth of isthmus 10·8–11·6 μ; thickness 19·2–20 μ.

Geogr. Distribution.—Nova Zembla. Greenland.

We have not seen any form exactly corresponding to the Desmid described by Wille as "*C. excavatum* var. *ellipticum*." Wille also describes the granules as disposed in longitudinal series, and figures them in concentric series (consult Pl.

LXXVII, fig. 13, which is a copy of Wille's original figure). It differs so considerably from *C. excavatum* in the form of its semicells and in the absence of an elongated isthmus, that it must necessarily be considered as a distinct species. The name "*Willei*" could not be adopted as a specific name as there is already a *Cosmarium Willei* Lagerh. (1886).

Var. **ordinatum** West & G. S. West. (Pl. LXXVII, fig. 14.)

Dysphinctium Willei Schmidle, forma Schmidle, Alg. Bern. Alp. 1894, p. 95, t. 6, f. 2.

Cosmarium subexcavatum var. *ordinatum* West & G. S. West, Notes Alg. II, 1900, p. 293, t. 412, f. 3; Alga-fl. Yorks. 1900, p. 86.

Cells a little longer than in the typical form; semicells broadly obovate; granules small, disposed in about 6 horizontal and 8 vertical series.

Length 29–37 μ; breadth 17–23 μ; breadth of isthmus 11·5–13·5 μ.

England.—Ingleton, W. Yorks!

Geogr. Distribution.—Switzerland.

This variety occurred somewhat sparingly among mosses on dripping limestone rocks. It is characterized by the regular disposition of the granules and also by the distinctly obovate semicells.

149. **Cosmarium orbiculatum** Ralfs. (Pl. LXXVII, figs. 15–17.)

Cosmarium orbiculatum Ralfs in Ann. Mag. Nat. Hist. xiv, 1844, p. 392, t. 11, f. 2; Brit. Desm. 1848, p. 107, t. 17, f. 5; t. 33, f. 9; Arch. in Pritch. Infus. 1861, p. 734; Rabenh. Flor. Europ. Alg. III, 1868, p. 173; Nordst. Norges Desm. 1873, p. 22; Kirchn. Alg. Schles. 1878, p. 152; Wolle, Desm. U. S. 1884, p. 77, t. 14, f. 20, 21; Cooke, Brit. Desm. 1887, p. 119, t. 43, f. 1 [figures poor]; Hansg. Prodr. Algenfl. Böhm. 1888, p. 249; De Toni, Syll. Alg. 1889, p. 962; Borge, Chlor. Norska Finmark. 1892, p. 9; West, Alg. W. Ireland, 1892, p. 159; Roy & Biss. Scott. Desm. 1894, p. 170; Nordst. Index Desm. 1896, p. 190; West & G. S. West, Alg. S. England, 1897, p. 491; Alga-fl. Yorks. 1900, p. 86; Alg. N. Ireland, 1902, p. 40.

Penium orbiculatum Kütz. Species Alg. 1849, p. 167.

Tessararthra orbiculata Grun. Desm. u. Pediast. österreich. Moore, 1858, p. 493.

Dysphinctium orbiculatum Reinsch, Algenfl. Franken, 1867, p. 181.

Ursinella orbiculata Kuntze, Revis. gen. plant. 1891, p. 925.

Cells small, twice as long as broad, deeply constricted, sinus widely open outwards from an acute apex; semicells circular; cell-wall covered with sub-

conical granules having no regular disposition, 14 or 15 showing at the margin. Vertical view circular. Chloroplasts axile, one in each semicell, with a central pyrenoid.

Zygospore subglobose, furnished with conical warts, about 20 visible at the margin.

Length 35–38 μ; breadth 18–20 μ; breadth of isthmus 6·5–8 μ; diam. zygosp. without warts 30 μ, with warts 35 μ.

England.—Westmoreland (*Ralfs*). Mickle Fell and Strensall Common, N. Yorks! Cullingworth, W. Yorks! Bisley Common, Surrey! Sussex (*Ralfs*). New Forest, Hants! Cornwall (*Ralfs*).

Wales.—Capel Curig! (*Cooke & Wills*), Llyn Padarn and near Bettws-y-Coed, Carnarvonshire!

Scotland.—Sutherland! Inverness, Aberdeen, Kincardine, Forfar, Perth, Argyll (*Roy & Bissett*).

Ireland.—Near Glenties, Donegal! Ballynahinch, Galway! Adrigole, Castletown, and Carrantuohill, Kerry! Dublin and Wicklow (*Archer*). Slieve Donard, Down!

Geogr. Distribution.—France. Germany. Galicia. Italy. Norway. Sweden. Finland. Greenland. United States.

C. orbiculatum is a characteristic species of somewhat rare occurrence. The zygospore is somewhat similar to that of *C. isthmium*, but the warts are not truncate-emarginate.

Forma **major**. (Pl. LXXVII, fig. 18.)

Length 55 μ; breadth 28 μ; breadth of isthmus 12·5 μ.

Wales.—Capel Curig, Carnarvonshire!

150. **Cosmarium prægrande** Lund. (Pl. LXXVII, fig. 19.)

Cosmarium prægrande Lund. Desm. Suec. 1871, p. 54, t. 3, f. 21; Boldt, Desmid. Grönland, 1888, p. 28; Börg. Bornh. Desm.-fl. 1889, p. 146, t. 6, f. 7; Borge, Süssw. Chlor. Archang. 1894, p. 19; Roy & Biss. Scott. Desm. 1894, p. 171; Nordst. Index Desm. 1896, p. 205.
Cosmaridium prægrande Hansg. Prodr. Algenfl. Böhm. 1888, p. 246.
Pleurotæniopsis prægrandis (Lund.) De Toni, Syll. Alg. 1889, p. 913.

Cells large, scarcely twice as long as broad, deeply constricted, sinus widely open from an acute apex; semicells globose; cell-wall densely covered with bluntly conical warts except for a small area at the apex, between the warts finely punctate. Chloroplasts parietal, with 4–6 bands in each semicell.

Zygospore unknown.

Length 97·2–104 μ; breadth 56–61·2 μ; breadth of isthmus 23–23·4 μ.

Scotland.—Near the Spittal of Glen Shee, Perth (*Roy & Bissett*).

Geogr. Distribution.—Norway. Sweden. Bornholm. Finland. N. Russia. Greenland.

This species has a most astonishing resemblance to the side view of *Cosmarium Brébissonii*, agreeing in the conical warts (or granules), in the bare place at each apex, and in the fine punctulation of the cell-wall. The form mentioned by Börgesen as occurring in Bornholm possessed hollow granules, a feature not mentioned by Lundell as occurring in Swedish specimens.

Note:—*Cosmarium sphæricum* Benn. ('Alg. N. Cornwall,' 1887, p. 17, t. 4, f. 22; Cooke 'Brit. Desm.' 1887, p. 189, t. 65, f. 5) appears to be the side view of a large *Cosmarium*, such as *C. Brébissonii* or *C. margaritatum*. Lagerheim has placed it as *C. prægrande* Lund. var. *sphæricum*, but we do not think there is sufficient evidence for regarding it as a form of *C. prægrande*. Judging by the extraordinarily inaccurate observations made by Bennett on various species of Desmids, we have little hesitation in regarding his published description and figure of "*C. sphæricum*" as merely an erroneous interpretation of the side view of some large species of *Cosmarium*.

151. **Cosmarium ornatum** Ralfs.

(Pl. LXXVIII, figs. 1–10.)

Cosmarium ornatum Ralfs, in Ann. Mag. Nat. Hist. xiv, 1844, p. 392, t. 11, f. 3; Hass. Brit. Freshw. Alg. 1845, p. 364, t. 86, f. 3; Ralfs, Brit. Desm. 1848, p. 104, t. 16, f. 7; Kütz. Spec. Alg. 1849, p. 176; Arch. in Pritch. Infus. 1861, p. 734; Rabenh. Flor. Europ. Alg. III, 1868, p. 169; Lund. Desm. Suec. 1871, p. 28; Kirchn. Alg. Schles. 1878, p. 153; Wolle, Desm. U. S. 1884, p. 82, t. 18, f. 39–42; t. 49, f. 23, 24; Cooke, Brit. Desm. 1887, p. 112, t. 40, f. 4; Hansg. Prodr. Algenfl. Böhm. 1888,

p. 201; De Toni, Syll. Alg. 1889, p. 1025; Börg. Desm. Brasil. 1890, p. 38; West, Alg. N. Wales, 1890, p. 290; Alg. W. Ireland, 1892, p. 158; Alg. Engl. Lake Distr. 1892, p. 728; Roy & Biss. Scott. Desm., 1894, p. 170; Nordst. Index Desm. 1896, p. 190; West & G. S. West, Alg. S. England, 1897, p. 491; Alga-fl. Yorks. 1900, p. 71; Alg. N. Ireland, 1902, p. 40; Scott. Freshw. Plankton, I, 1903, p. 527; Borge, Alg. erst. Regnell. Exped., II. Desmid. 1903, p. 100; West & G. S. West, Comp. Study Plankton Irish Lakes, 1906, p. 85.

Euastrum ornatum (Ralfs) Focke, Phys. Stud. 1847, I, p. 41 [t. 1, f. 2 ?].

Cosmarium ornatum Ralfs, forma, Lund. Desm. Suec. 1871, p. 28; Borge, Beiträge Alg. Schweden, 1906, p. 41.

C. ornatum var. *anglica* Racib. Nonn. Desm. Polon. 1885, p. 72.

C. ornatum var. *suecica* Racib. l.c. p. 72; Lütkem. Desm. Millstättersees, 1900, p. 68, t. 1, f. 24.

Ursinella ornata Kuntze, Revis. gen. plant. 1891, p. 925.

Cells small, as long as broad, deeply constricted, sinus narrowly linear with a slightly dilated apex; semicells reniform, with slightly produced, truncate apices, basal angles and lower parts of sides broadly rounded, upper parts of lateral margins immediately below the apex sometimes very slightly retuse, apex broadly truncate and straight; lateral margins with 7–9 prominent granules, slightly reduced in size just below the apex and often not reaching so far as the upper angles, apex with about 7 marginal granules; with a number of conspicuous granules within the lateral margins, often in short oblique series, and with one or two series of granules (variable both in size and number) within the apex; with a granulated protuberance in the centre of each semicell, granules conspicuous and variable both in size and disposition (sometimes arranged in short vertical series and sometimes more or less concentrically disposed). Side view of semicell depressed-subcircular, with a very slightly produced and truncate apex. Vertical view elliptic-oblong, with broadly rounded poles, and with a broad, granulate tumour at the middle on each side; central region of apex smooth. Chloroplasts axile, one in each semicell, with two pyrenoids.

Zygospore globose, and furnished with stout spines, arising from a broadly conical base, and furcate-emarginate at the apex.

Length 32–41 μ; breadth 33–41 μ; breadth of

isthmus 10–11·5 μ; thickness 22–24 μ; diam. zygosp. without spines 46–50 μ, with spines 70–95 μ.

England.—Cumberland! Westmoreland! W., N., and E. Yorks! Leicestershire (*Roy*). Essex (*Ralfs*). Surrey (with zygospores from Thursley Common)! Sussex (*Ralfs*). Hants (*Ralfs*); zygospores from New Forest! Devon! Cornwall!

Wales.—Capel Curig (*Cooke & Wills*), Bethesda, Llyn Idwal, Llyn Ogwen, Llyn-y-cwm-ffynon, and Moelfre, Carnarvonshire! Llyn Coron, Anglesey!

Scotland.—General! (*Roy & Bissett*). Rare in the plankton! Common in Lewis and Harris, Outer Hebrides!

Ireland.—Donegal! Mayo! Galway! Kerry! Dublin and Wicklow (*Archer*). Down! Rare in the lake-plankton of Galway and Kerry!

Geogr. Distribution.—France. Germany. Austria (including both Bohemia and Galicia). Poland. Italy. Portugal. Norway. Sweden. Bornholm. Denmark. Finland. N. and S. Russia. Iceland. United States. Brazil. Paraguay.

Cosmarium ornatum is a widely distributed species, occurring in bogs and at the margins of lakes. The widely truncate apex of the semicell projects very slightly, and furnishes the most constant and characteristic feature of the species. The general granulation of the semicell is fairly constant, but the granules covering the central protuberance are exceedingly variable in number and disposition. They may have a concentric disposition, or they may be arranged in somewhat irregular vertical series, and sometimes their disposition is quite irregular. In all cases there is a small, smooth area surrounding the central granules and separating them from the remaining granules of the semicell.

The figures of this Desmid given by Ralfs in his 'British Desmids,' 1848, t. 16, f. 7, are not very good. We believe the central granules to be incorrectly portrayed, and the amount of projection of the apices is distinctly exaggerated. These inaccuracies caused Lundell to state the differences between his Swedish specimens and the figures given by Ralfs, and led to the institution of "var. *anglica*" and "var. *suecica*" by Raciborski. We have examined numbers of

Cosmarium ornatum from the localities in which Ralfs obtained the species, and they are much more in agreement with those obtained from other parts of the British Islands than with that author's figures. Moreover, the British and Swedish specimens differ in no essential points. The creation of varietal names, such as those given by Raciborski, by an author who has not examined the original specimens, is greatly to be condemned.

Ralfs' figure of the zygospore is similarly not very good. The furcate spines are most probably portrayed too long.

Eichler and Gutwinski have described a *C. pseudoornatum* ('Nonn. spec. alg. nov.' 1894, p. 170, t. 5, f. 25), in which the apical part of the semicell does not project.

152. **Cosmarium commissurale** Bréb.

(Pl. LXXVIII, figs. 11–14.)

Heterocarpella commissuralis Bréb. in Chev. microscop. et de leur usage, Paris, 1839, p. 272 [name only].

Cosmarium commissurale Bréb. in Menegh. Synops. Desm. 1840, p. 220; Ralfs, Brit. Desm. 1848, p. 105, t. 16, f. 8; Kütz. Spec. Alg. 1849, p. 176; Bréb. Liste Desm. 1856, p. 131; Arch. in Pritch. Infus. 1861, p. 734; Rabenh. Flor. Europ. Alg. III, 1868, p. 170; Wolle, Desm. U. S. 1884, p. 83, t. 18, f. 49–51; Cooke, Brit. Desm. 1887, p. 113, t. 40, f. 5; De Toni, Syll. Alg. 1889, p. 1047; Roy & Biss. Scott. Desm. 1894, p. 44; Nordst. Index Desm. 1896, p. 77; West & G. S. West, Alg. S. England, 1897, p. 491; Alga-fl. Yorks. 1900, p. 71; Notes Alg. III, 1903, p. 75.

Euastrum commissurale Wallich, Desm. Low. Bengal, 1860, p. 284, t. 14, f. 12–13.

Didymidium (*Cosmarium*) *commisurale* Reinsch, Algenfl. Franken, 1867, p. 120 [forma A].

Ursinella commissuralis Kuntze, Revis. gen. plant. 1891, p. 924.

Cells small, about $1\frac{1}{2}$ times as broad as long, very deeply constricted, sinus at first narrow and closed, then widely dilated (often subrhomboidal); semicells narrowly subreniform with a slightly produced and widely truncate apex; lateral parts (almost "lobes") of semicell granulate, with 6–8 granules showing at the margin and 7–10 within the margin, apex with 6–7 marginal granules, in centre of semicells with a large granulate protuberance. Side view of semicell transversely elliptic with a slightly produced and truncate apex, sides and apex granulate. Vertical view about twice as long as broad, with a large granulate pro-

tuberance at the middle on each side, slightly constricted below the poles, which are inflated and granulate.

Zygospore globose, furnished with long, often slightly curved spines, arising from broad, conical bases, and furcate-emarginate at the apex.

Length 27–33 μ; breadth 38–45 μ; breadth of isthmus 9·6–12 μ; thickness 18–25 μ; diam. zygosp. without spines 35–42·5 μ, with spines 75–83 μ.

England.—Rawcliffe Common, W. Yorks! Strensall Common, N. Yorks! Near Bristol, Gloucestershire (*Thwaites*). Harefield, Middlesex! Piltdown Common, Sussex (*Jenner*). Cornwall (with zygospores)!

Scotland.—Aberdeen, Kincardine, Forfar (*Roy & Bissett*).

Geogr. Distribution.—France. Germany. Sweden. India. United States. Brazil.

C. commissurale is a characteristic species, and is very rare except in Cornwall, in the western districts of which county it is generally distributed, often occurring in abundance in small pools and ditches.

Var. **acutum** Bréb.

C. commissurale Bréb. var. *acutum* Bréb. Liste Desm. 1856, p. 131; Roy & Biss. Scott. Desm. 1893, p. 44.

Lateral angles (or lobes) of semicells narrower and attenuated.

Length and breadth as in the typical form.

Scotland.—Near Bishop's Loch and near Aboyne, Aberdeen; Mavis Bank, Loch of Lumgair, near Stonehaven, and Dalbrake in Strachan, Kincardine (*Roy & Bissett*).

Geogr. Distribution.—France.

Var. **crassum** Nordst. (Pl. LXXVIII, figs. 15, 16.)

C. commissurale Bréb. var. *crassum* Nordst. Desm. Brasil. 1870, p. 213, t. 3, f. 19; West, Alg. W. Ireland, 1892, p. 158; Borge, Alg. erst. Regnell. Exped. II. Desmid. 1903, p. 100.

Cells about $1\frac{1}{4}$ times as broad as long, sinus not closed but not nearly so much widened inwardly as in

the type; lateral angles (or lobes) of semicells much stouter; central granules variable, sometimes as in the type, but often reduced in number (with three large central warts surrounded by one ring of 8 granules).

Length 28–37 μ; breadth 31–43 μ; breadth of isthmus 10·5–13 μ; thickness 22–26·5 μ.

Scotland.—Rhiconich, Sutherland!

Ireland.—Cromagloun and Glen Caragh, Kerry!

Geogr. Distribution.—Brazil. Paraguay.

153. **Cosmarium dentiferum** Corda.

(Pl. LXXVIII, figs. 17, 18.)

Cosmarium dentiferum Corda in Almanach de Carlsbad, 1840, p. 215, t. 6, f. 41; Nordst. Bornh. Desm. 1888, p. 192, t. 6, f. 4–5; Roy & Biss. Scott. Desm. 1894, p. 45; Nordst. Index Desm. 1896, p. 101.

Cells fairly large, about as long as broad or very slightly longer, deeply constricted, sinus narrow and closed, with a widely dilated extremity; semicells reniform, with a slightly depressed (sometimes faintly retuse) apex. Vertical view oblong, sides very slightly convex, poles rounded. Cell-wall granulate, granules rounded, disposed in vertical and obliquely decussating series, about 40 showing at the margin of the semicell.

Zygospore unknown.

Length 92–104 μ; breadth 89–100 μ; breadth of isthmus 28–37 μ; thickness 40 μ.

England.—In Bracebridge Pool, Sutton Park, Warwickshire!

Scotland.—Aberdeen and Kincardine (*Roy & Bissett*).

Geogr. Distribution.—Germany. Bornholm. Iceland.

This species is very closely allied to *C. margaritatum* and *C. conspersum* (inclus. *C. latum*), only differing in the form of the semicells. It is the greatly rounded superior angles which cause the semicells to appear more or less reniform. Messrs. Roy and Bissett state that it is very rare in Scotland, but that they had passed it over as a form of *C. latum*.

154. **Cosmarium reniforme** (Ralfs) Arch.

(Pl. LXXIX, figs. 1, 2; Pl. LXXXII, fig. 15.)

Cosmarium margaritiferum Menegh. var. *reniformis* Ralfs, Brit. Desm. 1848, p. 100, t. 16, f. 2 *a*.

C. margaritiferum forma *genuina* Nordst. Norges Desm. 1873, p. 11.

C. reniforme (Ralfs) Arch. in Journ. Bot. 1874, p. 92; Nordst. Desm. Arctoæ, 1875, p. 40; Wolle, Desm. U. S. 1884, p. 76, t. 14, f. 10–11; Cooke, Brit. Desm. 1887, p. 104, t. 42, f. 10; Hansg. Prodr. Algenfl. Böhm. 1888, pp. 200, 250; De Toni, Syll. Alg. 1889, p. 982; Roy in Journ. Bot. 1890, p. 337; West, Alg. W. Ireland, 1892, p. 153; Alg. Engl. Lake Distr. 1892, p. 727; Lütkem. Desm. Attersees, 1893, p. 557; Roy & Biss. Scott. Desm. 1894, p. 174; Nordst. Index Desm. 1896, p. 223; West & G. S. West, Alg. S. England, 1897, p. 488; Schmidle, Lappmark Süsswasseralgen, 1898, p. 34; West & G. S. West, Some Desm. U. S. 1898, p. 307, t. 17, f. 9; G. S. West, Alga-fl. Cambs. 1899, p. 217; West & G. S. West, Alga-fl. Yorks. 1900, p. 71; Börg. Freshw. Alg. Færoës, 1901, p. 227; West & G. S. West, Alg. N. Ireland, 1902, p. 37; Scott. Freshw. Plankton, I, 1903, p. 527; Borge, Alg. erst. Regnell. Exped. II, Desmid. 1903, p. 87; Larsen, Freshw. Alg. E. Greenland, 1904, p. 88; West & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 18; Further Contrib. Freshw. Plankton Scott. Lochs, 1905, p. 485; Comp. Study Plankton Irish Lakes, 1906, p. 85; Borge, Alg. Argentina u. Boliv. 1906, p. 8; Beiträge Alg. Schweden, 1906, p. 31.

Ursinella reniformis Kuntze, Revis. gen. plant. 1891, p. 925.

Cells of medium size, very slightly longer than broad, deeply constricted, sinus narrow and closed, open outwards and widely dilated at the extremity; semicells reniform. Side view of semicell circular. Vertical view elliptic. Cell-wall granulate, granules rounded, disposed in obliquely decussating series and sometimes in indistinct vertical series, about 30–33 showing at the margin of a semicell. Chloroplasts axile, with two pyrenoids.

Zygospore globose and smooth.

Length 46–57 μ; breadth 44–54 μ; breadth of isthmus 14–17 μ; thickness 26–29 μ; diam. zygosp. 54–60 μ.

England.—Cumberland! Westmoreland! (*Bissett*). Lancashire! W., N., and E. Yorks! Leicestershire (*Roy*). Lincolnshire! Cambs! Oxfordshire! Surrey! Kent! Hants! (*Roy*). Wilts! Cornwall! (*Marquand*).

Wales.—Capel Curig!, Llyn Ogwen!, Yr Orsedd!, and Glyder Fawr (*Roy*), Carnarvonshire.

Scotland.—General! (*Roy & Bissett*). Orkneys! Shetlands! Rare in the plankton! Lewis, Harris (with zygospores), and N. Uist, Outer Hebrides!

Ireland.—Donegal! Mayo! Galway! Kerry! Dublin and Wicklow (*Archer*). Armagh! Londonderry! Plankton of the lakes of Galway and Kerry!

Geogr. Distribution.—France. Germany. Switzerland. Austria and Galicia. Italy. Norway. Sweden. Faeroes. Greenland. Spitzbergen. United States. Brazil. Argentina.

This species is generally distributed throughout the British Islands, occurring commonly at the margins of lakes or of old ponds and pools, and in boggy springs. It is characterized by its reniform semicells, the form of which is in a large measure due to the widely dilated extremity of the sinus. The granulation of the cell-wall is one of the most pronounced features of the species. The marginal granules (approximately 30 on each semicell) often stand out like rounded beads, and the granules as a whole are disposed in slightly curved series crossing one another obliquely. In some individuals the granules are more or less evidently disposed in vertical series, but there is often considerable irregularity in the whole granulation.

C. reniforme has very little in common with *C. margaritiferum*.

The zygospore was first discovered in Ireland by Archer, who pointed out its smooth and globular character.

Lütkemüller has recorded Austrian specimens of *C. reniforme* with a length of 57–74 μ and a breadth of 50–62 μ, but British forms do not attain such dimensions.

Var. **compressum** Nordst. (Pl. LXXIX, figs. 3, 4.)

C. reniforme (Ralfs) Arch. var. *compressum* Nordst. in Bot. Notis. 1887, p. 159; Freshw. Alg. N. Zeal. 1888, p. 46, t. 5, f. 5; West, Alg. Engl. Lake Distr. 1892, p. 727; Turn. Freshw. Alg. E. India, 1893, p. 73; Racib. Desm. Tapakoomas, 1895, p. 33; West & G. S. West, Some Desm. U. S. 1898, p. 307, t. 17, f. 10; G. S. West, Alga-fl. Cambs. 1899, p. 217; West & G. S. West, Alg. N. Ireland, 1902, p. 38.

Semicells depressed, with the median part of the apex sometimes slightly truncate; vertical view elliptic-oblong or oblong, narrower than in the typical form.

Length 46–64 μ; breadth 47–56 μ; breadth of isthmus 13–18 μ; thickness 24–28 μ.

England.—Hawkshead, Lancashire! Twenty-foot River, between March and Guyhirne, Cambs!

Scotland.—Loch Ness, Inverness!

Ireland.—Lough Derryad, Armagh!

Geogr. Distribution.—India. New Zealand. United States. British Guiana.

Var. **elevatum** West & G. S. West. (Pl. LXXIX, fig. 6.)

C. reniforme (Ralfs) Arch. var. *elevatum* West & G. S. West, Some Desm. U. S. 1898, p. 307, t. 17, f. 11.

Cells almost $1\frac{1}{2}$ times longer than broad; semicells higher, with the basal angles subrectangular and the lower part of the sides subparallel.

Length 52 μ; breadth 36 μ; breadth of isthmus 14 μ; thickness 24 μ.

Geogr. Distribution.—United States (Michigan).

Typical specimens of this variety have not been observed in the British Islands; but a form observed from Wicken Fen, Cambridgeshire, possessed the subrectangular basal angles which characterize the var. *elevatum* (consult G. S. West, 'Alga-fl. Cambs.' 1899, p. 23). This form had a length of 54 μ and a breadth of 46 μ (Pl. LXXIX, fig. 7).

Var. **apertum** *var. nov.* (Pl. LXXIX, fig. 5.)

? *C. margaritiferum* (Turp.) Menegh. var. *incisum* Kirchn. Alg. Schles. 1878, p. 150; Hansg. Prodr. Algenfl. Böhm. 1888, p. 198; ? Boldt, Desmid. Grönland, 1888, p. 26, t. 2, f. 28.

? *C. margaritiferum* (Turp.) Menegh. forma isthmo elongato, Borge, Süssw. Chlor. Archang. 1894, p. 20, t. 2, f. 15.

? *C. Netzerianum* Schmidle, Beitr. alp. Alg. 1895, p. 390, t. 15, f. 19.

Semicells not reniform, inferior margin slightly convex; sinus slightly open, very gradually opening outwards from a rounded apex.

Length 56 μ; breadth 48 μ; breadth of isthmus 19 μ.

Ireland.—Carrantuohill, Kerry!

This variety differs in the form of its semicells, which, owing to the open sinus, are not reniform. The granulation is typical. It seems likely that both *C. margaritiferum* var. *incisum* Kirchn. and *C. Netzerianum* Schmidle should be relegated to this variety, but the examination of original specimens would be necessary to confirm this suggestion.

In outward form the semicells have a resemblance to those of *C. Simii* Roy & Biss.

155. **Cosmarium Turneri** Roy.

(Pl. LXXIX, figs. 8, 9.)

Cosmarium margaritiferum Ralfs, Brit. Desm. 1848, t. 33, f. 6 *b*.
C. Turneri Roy, Freshw. Alg. Enbridge Lake and Vicin. 1890, p. 337.

Cells of medium size, a little longer than broad, deeply constricted, sinus narrowly linear with a very slightly dilated apex; semicells elliptic-subreniform. Side view of semicell subcircular. Vertical view elliptic. Cell-wall granulate, granules of uniform size (or very slightly reduced in size above the isthmus) and disposed in indistinct oblique series, about 20–23 visible at the margin of each semicell.

Zygospore globose, furnished with short furcate-emarginate spines, each of which arises from a large conical base.

Length 56–58 μ; breadth 51–53 μ; breadth of isthmus 14–16 μ; thickness 28 μ; diam. zygosp. without spines 53 μ, with spines 74 μ.

England.—Enbridge Lake, Hants (*Roy*).

Ireland.—Lough Gartan, Donegal!

We are unable to give the locality from which Ralfs obtained specimens and zygospores of this plant, as that author did not discriminate between the different species which he included under the name "*Cosmarium margaritiferum*." We have ourselves only once observed a *Cosmarium* which we could with any degree of certainty refer to *C. Turneri* Roy. This specimen we have figured (Pl. LXXIX, fig. 9).

C. Turneri differs from *C. margaritiferum* in the form of its semicells, in the nature of its granulation, and in its spiny zygospore. It differs from *C. reniforme* in its less reniform semicells, with fewer and more distant granules, and in its spiny zygospore.

Hansgirg has further complicated the synonymy of the genus by naming a form of *C. Pseudobroomei* as "*Cosmarium Turneri*" (*vide* Hansgirg in 'Sitzungsber. d. k. böhm. Ges. d. Wissensch. math. nat. Cl.' 1902, p. 101 [= *Cosmarium* sp. Turn. 'Freshw. Alg. E. India,' 1893, p. 72, t. 23, f. 10]).

156. **Cosmarium Brébissonii** Menegh.

(Pl. LXXIX, figs. 10, 11.)

Cosmarium Brébissonii Menegh. in Desmaz. Pl. crypt. France, 1838, fasc. 19, no. 903; Synops. Desm. 1840, p. 219; Ralfs, Brit. Desm. 1848, p. 100, t. 16, f. 3; Arch. in Pritch. Infus. 1861, p. 732; Rabenh. Flor. Europ. Alg. III, 1868, p. 158; Lund. Desm. Suec. 1871, p. 27; Delp. Desm. subalp. 1877, p. 30, t. 9, f. 17–22; Wolle, Desm. U. S. 1884, p. 75, t. 13, f. 10–11; Cooke, Brit. Desm. 1887, p. 100, t. 38, f. 2; Hansg. Prodr. Algenfl. Böhm. 1888, p. 200; De Toni, Syll. Alg. 1889, p. 983; West, Alg. N. Wales, 1890, p. 289; Alg. W. Ireland, 1892, p. 152; Alg. Engl. Lake Distr. 1892, p. 726; Roy & Biss. Scott. Desm. 1894, p. 44; Nordst. Index Desm. 1896, p. 67; West & G. S. West, Alg. S. England, 1897, p. 488; Alga-fl. Yorks. 1900, p. 71; Börg. Freshw. Alg. Færöes, 1901, p. 228; West & G. S. West, Alg. N. Ireland, 1902, p. 37; Scott. Freshw. Plankton, I, 1903, p. 527; Freshw. Alg. Orkneys and Shetlands, 1905, p. 19; Comp. Study Plankton Irish Lakes, 1906, p. 85.

C. Botrytis Menegh. var. *Brébissonii* (Menegh.) Rabenh. Krypt. Fl. Sachs. 1863, p. 200.

Didymidium (*Cosmarium*) *Brébissonii* Reinsch, Algenfl. Franken, 1867, p. 122.

Cosmarium Brébissonii Menegh. forma *subtumida* Nordst. Norges Desm. 1873, p. 12.

C. Brébissonii var. *horrida* Jacobs. Desm. Danem. 1876, p. 194.

Ursinella Brébissonii Kuntze, Revis. gen. plant. 1891, p. 924.

Cosmarium Brébissonii forma *erosa* West, Alg. W. Ireland, 1892, p. 152, t. 21, f. 6; Alg. Engl. Lake Distr. 1892, p. 726; West & G. S. West, Alg. S. England, 1897, p. 488; Alga-fl. Yorks. 1900, p. 71.

Cells large, about $1\frac{1}{3}$ times as long as broad, deeply constricted, sinus narrowly linear with a dilated extremity; semicells semi-elliptic, basal angles rounded, apex flattened and subtruncate; densely covered with large conical granules (or papillæ), arranged in no definite order, but reduced at the apex, from the middle of which they are entirely wanting. Side view of semicell subcircular with a depressed (almost flattened) apex. Vertical view elliptic-subrhomboid, or elliptic with widely tumid sides, the space in the middle of the apex which is destitute of granules clearly visible, and also the reduction in size of the granules in the vicinity of the apex. Cell-wall between the large granules densely and strongly punctate. Chloroplasts axile, each with two pyrenoids.

Zygospore (consult *Archer* in 'Quart. Journ. Micr. Sci.' xiii, 1872, p. 100).

Length 88–110 μ; breadth 67–79 μ; breadth of isthmus 22–26 μ; thickness 47–58 μ.

England.—Cumberland! Westmoreland! (*Bissett*). Lancashire! W. and N. Yorks! Cheshire (*Roy*). Warwickshire! (*Ralfs; Wills*). Surrey! Sussex! Kent! Hants! Wilts! Devon! (*Bennett*). Cornwall! (*Ralfs; Marquand*).

Wales.—General in Carnarvonshire and Merioneth!

Scotland.—General! (*Roy & Bissett*). Shetlands! Common in the Outer Hebrides!

Ireland.—Donegal! Galway! Kerry! Dublin and Wicklow (*Archer*). Down! Antrim! Londonderry! Very rare in the plankton of the Kerry lakes!

Geogr. Distribution.—France. Germany. Switzerland. Austria and Galicia. Italy. Faeroes. Norway. Sweden. Denmark. Finland. Russia. India. United States.

This characteristic species is generally distributed in the *Sphagnum*-bogs of the British Islands, occurring in association with *Cosmarium Cucurbita, C. margaritiferum, C. difficile, Euastrum crassum, E. ansatum, Xanthidium armatum, Micrasterias truncata, M. denticulata,* and other species which thrive amongst submerged *Sphagnum*. It is not very closely related to any other British species, although in its granulation it is without doubt nearest to *C. margaritiferum*.

Up to the present it has been very imperfectly described. The central part of each apex is destitute of granules, and there is also a considerable reduction in the size of the granules immediately surrounding this area. The actual smooth area, and also the amount of reduction of the apical granules, varies greatly in different individuals. We had described the condition in which the maximum reduction occurs as "forma *erosa*," but we now consider it impossible to draw any line of demarcation between the forms of this species. All the European specimens we have examined have the reduced condition of the granules at the apices, and the cell-wall is in all cases densely punctate between the granules. Nordstedt's "forma *subtumida*" is merely one of the ordinary forms of the species. The sides of the vertical view are invariably subtumid, and the thickness of the cell commonly greater than that mentioned by Nordstedt for his form. The large conical, almost papilliform granules are solid.

157. **Cosmarium Logiense** Bissett.

(Pl. LXXX, figs. 1, 2.)

Cosmarium Logiense Bissett, Desm. Windermere, 1884, p. 194, t. 5, f. 4; Cooke, Brit. Desm. 1887, p. 104, t. 41, f. 5; West, Alg. N. Wales, 1890, p. 289; Alg. W. Ireland, 1892, p. 153; Alg. Engl. Lake Distr. 1892, p. 727; Roy & Biss. Scott. Desm. 1894, p. 167, t. 2, f. 15; Nordst. Index Desm. 1896, p. 159; West & G. S. West, Alg. S. England, 1897 p. 488; Alga-fl. Yorks. 1900, p. 71.

Cells of about medium size, deeply constricted, sinus narrowly linear with a dilated extremity; semicells reniform, with the basal angles rounded but slightly subrectangular, dorsal region somewhat elevated, often slightly flattened or even faintly retuse in the middle of the apex. Side view of semicell subcircular. Vertical view elliptic. Cell-wall uniformly granulate, granules rather small and somewhat densely arranged in obliquely decussating and vertical series, about 14–15 oblique series and about 17 vertical series; 28–33 granules visible at the margin of each semicell. Chloroplasts axile, each with two pyrenoids.

Zygospore unknown.

Length 61–65 μ; breadth 48–50 μ; breadth of isthmus 16–18 μ; thickness 32–33 μ.

England.—Angle Tarn and Borrowdale, Cumberland! Near Bowness, Westmoreland! (*Bissett*). Ingleton, Bowland Knotts, and Cocket Moss near Giggleswick, W. Yorks! Mickle and Great Shunnor Fells, N. Yorks! Richmond Park, Surrey! Slapton Sands, Devon!

Wales.—Near Bethesda, Bettws-y-coed, Glyder Fawr (at 2,700 ft.), Llyn Cwlyd, and Y Foel Fras, Carnarvonshire!

Scotland.—Inverness, Aberdeen, Forfar, Perth!, Dumbarton (*Roy & Bissett*).

Ireland.—Roundstone, Galway! Cloonee Lough, Carrantuohill, and Castletown, Kerry!

Geogr. Distribution.—Galicia in Austria (a form). W. Indies.

C. Logiense was discovered by Bissett from the English Lake District, in which area it is more frequent than in any

other part of the British Islands. Bissett published no description of the species and only a very poor figure, but in 1894 Messrs. Roy and Bissett published an excellent figure in their 'Scottish Desmids' (pl. 2, f. 15). We have found it in several parts of the British Islands, but never in abundance.

C. Logiense should be compared with *C. reniforme*, from which it is distinguished by its proportionately greater length and by the smaller size of the granules. The semicells are of a different form from those of *C. reniforme*, and the apex of the sinus is not so dilated.

In 1899 Borge described and figured what he imagined to be typical *C. Logiense*. He had evidently overlooked the figure published by Messrs. Roy and Bissett, and his Cuban specimens (*vide* Borge, 'Trop. u. subtrop. Süssw.-Chlor.' 1899, p. 19, t. 1, f. 21) represent some other Desmid, possibly a form of *C. pulchellum* Turn.

158. **Cosmarium granulatum** West.

(Pl. LXXX, fig. 3.)

Cosmarium granulatum West, Alg. N. Yorks. 1889, p. 292, t. 291, f. 4; Nordst. Index Desm. 1896, p. 134; West & G. S. West, Alga-fl. Yorks. 1900, p. 72.

Cells large, deeply constricted, sinus narrowly linear, very slightly dilated at the extremity and opening outwards; semicells very broadly elliptical with a rather flattened base, sides and apex much rounded. Side view of semicell elliptic. Vertical view elliptic and slightly compressed. Cell-wall finely granulate, granules very small and flattened, causing the margin of the semicell to be minutely undulate, those granules near the margin arranged in concentric series, those in the central part of the semicell irregularly disposed and reduced in size.

Zygospore unknown.

Length 125 μ; breadth 85 μ; breadth of isthmus 25 μ; thickness 50 μ.

England.—Crook Ghyll near Buckden, W. Yorks! Cronkley Fell, N. Yorks!

This species is readily distinguished by the form of its semicells and its minute granulation. We have not observed any living specimens and are therefore unable to describe the chloroplasts.

159. **Cosmarium Portianum** Arch.

(Pl. LXXX, figs. 4–7.)

Cosmarium orbiculatum De Bary, Conj. 1858, p. 41, t. 6, f. 49, 50; Delp. Desm. subalp. 1877, p. 11, t. 7, f. 46–48. [Not *C. orbiculatum* Ralfs, 1844.]
Cosmarium Portianum Arch. in Quart. Journ. Micr. Sci. viii, 1860, p. 235, t. 11; in Pritch. Infus. 1861, p. 733; Rabenh. Flor. Europ. Algar. III, 1868, p. 160, f. xyl. *b*, *c* (p. 108); Lund. Desm. Suec. 1871, p. 46; Nordst. Desm. Ital. 1876, p. 28; Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 34; Wolle, Desm. U. S. 1884, p. 77, t. 14, f. 12–13 [14?]; Cooke, Brit. Desm. 1887, p. 103, t. 39, f. 3; De Toni, Syll. Alg. 1889, p. 986; West, Alg. N. Wales, 1890, p. 289; Alg. W. Ireland, 1892, p. 152; Alg. Engl. Lake Distr. 1892, p. 727; Lütkem. Desm. Attersees, 1893, p. 558; Roy & Biss. Scott. Desm. 1894, p. 171; Schmidle, Alg. Geb. Oberrheins, 1894, p. 550, t. 28, f. 8; Börg. Ferskv. Alg. Östgrönl. 1894, p. 12; Nordst. Index Desm. 1896, p. 204; West & G. S. West, Alg. S. England, 1897, p. 488; Schmidle, Lappmark Süsswasseralgen, 1898, p. 32; West & G. S. West. Alga-fl. Yorks. 1900, p. 72; Alg. N. Ireland, 1902, p. 38; Borge, Beiträge Alg. Schweden, 1906, p. 31.
C. pseudomargaritiferum Reinsch, Contrib. Alg. et Fungi, 1875, p. 84, t. 16, f. 12 [= *C. Portianum* according to Archer].
? *C. discretum* Benn. Alg. N. Cornwall, 1887, p. 17, t. 4, f. 23 [figure bad].
? *Dysphinctium discretum* De Toni, Syll. Alg. 1889, p. 885.
Ursinella Portiana Kuntze, Revis. gen. plant. 1891, p. 925.
Cosmarium Portianum Arch. var. *orthostichum* Schmidle, Alg. Geb. Oberrheins, 1894, p. 549, t. 28, f. 7; Chlorophy.-Fl. Torfstiche Virnheim, 1894, p. 56, t. 7, f. 11; Beitr. alp. Alg. 1895, p. 390; West & G. S. West, Alg. S. England, 1897, p. 488; Schmidle, Lappmark Süsswasseralgen, 1898, p. 32; West & G. S. West, Alg. N. Ireland, 1902, p. 38.

Cells rather small, about $1\frac{1}{3}$ times as long as broad, deeply constricted, sinus gradually opening from a rounded extremity, isthmus slightly elongated; semicells elliptic and granulate; granules rounded, disposed in about 10 vertical series, and sometimes in oblique series also (rarely more or less irregular), with about 20–23 visible at the margin of each semicell. Side view of semicell circular. Vertical view elliptic. Chloroplasts axile, one in each semicell, with a central pyrenoid.

Zygospore globose, furnished with elongated, obtusely-conical warts.

Length 30–40 μ; breadth 22–30 μ; breadth of isthmus 8–13 μ; thickness 16–20 (rarely up to 24) μ; diam. zygosp. without warts 31 μ, with warts 40 μ.

England.—Cumberland! Westmoreland! (*Bissett*). Lancashire! W., N., and E. Yorks! Cheshire (*Roy*). Surrey! Devon! Cornwall! (*Marquand*).

Wales.—Generally distributed!

Scotland.—General! Zygospores at Brimmond, Aberdeen (*Roy & Bissett*). General in the Outer Hebrides!

Ireland. — Donegal! Mayo! Galway! Kerry! Dublin and Wicklow (*Archer*). Armagh! Down! Londonderry!

Geogr. Distribution.—France. Germany. Belgium. Austria and Galicia. Poland. Italy. Norway. Sweden. Bornholm. Finland. N. Russia. Spitzbergen. Nova Zembla. Siberia. Central China. India. Ceylon. Australia. Japan. Azores. United States. Brazil.

C. Portianum is generally distributed in the western boggy areas of the British Islands, and it also occurs somewhat sparingly in other districts. It is characterized by its elliptic semicells both in front and vertical view, by its open sinus, its slightly elongated isthmus, and by its granulation. It should be carefully compared with *C. orbiculatum* Ralfs and *C. isthmium* West.

The species was originally described by Archer from Ireland, but that author did not give the details of the disposition of the granules. We have examined large numbers of British specimens, more especially Irish ones, and we find that the general arrangement of the granules is in vertical series, about ten of which are visible in the front view of the empty semicell. Very often the granules are also disposed in indistinct oblique series, and in rare cases the disposition is more or less irregular. Schmidle's "var. *orthostichum*" must therefore be considered as in no way different from typical Irish examples such as those originally examined by Archer.

Messrs. Roy and Bissett found the zygospores in Aberdeenshire, and stated that they agreed with the figure given by De Bary ('Conj.' 1858, t. 6, f. 50) of a zygospore which that author erroneously referred to *C. orbiculatum* Ralfs. De Bary's figure must therefore be taken to represent the zygospore of *C. Portianum* (*vide* Pl. 103, fig. 4). Confirmation of this view is found in the fact that the zygospores of the closely allied species *C. orbiculatum* and *C. isthmium* are similarly furnished with elongated conical warts (consult Pl. LXXVII, figs. 8 and 9, and also fig. 17).

The spiny zygospore figured by Wolle as that of *C.*

Portianum (*vide* Pl. LXXX, fig. 8) belongs undoubtedly to some other species. It is also questionable whether the smooth zygospore figured by Reinsch of "*C. pseudomargaritiferum*" (*vide* Pl. LXXX, fig. 9) should be regarded as that of *C. Portianum*, notwithstanding Archer's expressed opinion that Reinsch's species was identical with his *C. Portianum*. If this be the case, then the zygospore figured by Reinsch is immature, not having as yet developed the conical warts.

The tropical forms of this species are considerably smaller than those occurring in temperate regions. [Length 20–25 μ; breadth 14·5–19 μ; breadth of isthmus 5–8·5 μ; thickness 10–12·5 μ.]

Var. **nephroideum** Wittr. (Pl. LXXX, figs. 10, 11.)

C. Portianum Arch. var. *nephroideum* Wittr. Gotl. Öl. sötv. Alg. 1872, p. 57; Nordst. Bornh. Desm. 1888, p. 193, t. 6, f. 15; Heimerl, Desm. alpin. 1891, p. 596; Gutw. Flor. glonów Galic. 1892, p. 129; West, Alg. W. Ireland, 1892, p. 153; Lütkem. Desm. Central China, 1900, p. 119; West & G. S. West, Alg. N. Ireland, 1902, p. 38.
? *C. armillatum* Turner, Freshw. Alg. E. India, 1893, p. 55, t. 8, f. 22.
C. nephroideum (Wittr.) Roy & Biss. Scott. Desm. 1894, p. 169, t. 2, f. 3.

Usually smaller than the type; semicells subreniform or semicircular-elliptic.

Length 25–31 μ; breadth 22–27 μ; breadth of isthmus 7–10 μ; thickness 12–16 μ.

Scotland.—Glen Clunie near Braemar, Aberdeen; Arran (*Roy & Bissett*).

Ireland.—Dungloe, Loughs Cloncarney and Darragh, and near Lough Magrath, Donegal! Lakes east of Lough Bofin, Galway!

Geogr. Distribution.—Germany. Austria and Galicia. Sweden. Faeroes. Iceland. Central China.

This variety is distinguished by the form of its semicells, which are considerably flattened at the ventral margin. The granules are rather smaller than in the type, but they have a similar disposition in vertical series.

160. **Cosmarium orthostichum** Lund. (Pl. LXXX, figs. 12–19.)

Cosmarium orthostichum Lund. Desm. Suec. 1871, p. 24, t. 2, f. 9; Wolle, Desm. U. S. 1884, p. 78, t. 18, f. 4–5; Cooke, Brit. Desm. 1887, p. 105, t. 42, f. 3; De Toni, Syll. Alg. 1889, p. 963; West, Alg. N. Wales, 1890,

p. 289; Alg. W. Ireland, 1892, p. 155; Roy & Biss. Scott. Desm. 1894, p. 170; Nordst. Index Desm. 1896, p. 191; West & G. S. West, Alg. S. England, 1897, p. 490; Schmidle, Lappmark Süsswasseralgen, 1898, p. 32; G. S. West, Variation Desm. 1899, p. 391, t. 11. f. 1–4; West & G. S. West, Alga-fl. Yorks. 1900, p. 72; Alg. N. Ireland, 1902, p. 42; Notes Algæ, III, 1903, p. 75.

Ursinella orthosticha Kuntze, Revis. gen. plant. 1891, p. 925.

Cells rather small, a little longer than broad, deeply constricted, sinus narrow with a slightly dilated extremity; semicells subelliptic or subreniform-elliptic, dorsal margin somewhat more convex than ventral margin, median part of apex rarely straight. Side view of semicell circular. Vertical view elliptic, ratio of axes about 1 : 1·3. Cell-wall granulate; granules relatively large, and somewhat distant, normally arranged in 7 or 8 vertical series, with 3 or 4 granules in each series (median granules rarely duplicated), 11 to 14 visible at the margin of the semicell; in the vertical view the granules are sometimes approximately arranged in transverse series, and at other times there is a clear central space. Chloroplasts axile, one in each semicell, with a central pyrenoid.

Zygospore unknown.

Length 32–36 μ; breadth 28–33 μ; breadth of isthmus 9·5–11 μ; thickness 18–24 μ.

England.—Cullingworth, W. Yorks! Thursley Common, Surrey! New Forest, Hants!

Wales.—Capel Curig and Llyn-y-cwn-ffynon, Carnarvonshire!

Scotland.—Aberdeen, Kincardine, Forfar!, Perth, Argyll (*Roy & Bissett*). Sutherland! Lewis and Harris, Outer Hebrides!

Ireland.—Near Lough Machugh, Donegal! Derryclare Lough and Ballynahinch, Galway! Glengariff, Kerry!

Geogr. Distribution.—Austria and Galicia. Norway. Sweden. United States.

C. orthostichum is an uncommon species, apparently restricted to the old deep *Sphagnum*-bogs and adjacent boggy pools which are fed by bottom springs. It is characterized by the possession of comparatively large

granules arranged in approximately vertical and horizontal series across the surface of the semicells. The vertical arrangement is generally more evident than the horizontal, the latter being at times replaced by oblique series. The granules sometimes exhibit a variation in relative size, especially in the centre of the semicells, and the large ones are not infrequently duplicated. The disposition of the granules in the vertical view is also somewhat variable.

Var. **pumilum** Lund. (Pl. LXXX, figs. 20, 21.)

C. orthostichum Lund. var. *pumilum* Lund. Desm. Suec. 1871, p. 25, t. 2, f. 10; Boldt, Siber. Chlorophy. 1885, p. 108; West, Alg. Engl. Lake Distr. 1892, p. 727; Roy & Biss. Scott. Desm. 1894, p. 170.

Smaller than the typical form, semicells oblong-elliptic, granules disposed in 6 vertical and 3 horizontal series.

Length 21·5–25 μ; breadth 20 μ; breadth of isthmus 5–8 μ; thickness 12·5–14 μ.

England.—Borrowdale, Cumberland! Helvellyn, Westmoreland!

Scotland.—Slewdrum, Forest of Birse, Dawin, Dalbagie, and Glen Clunie, Aberdeen; Kerloch and Bishop's Dam, Kincardine; Glen Clova, Forfar; near Kingshouse, Argyll (*Roy & Bissett*). Spittal of Glen Shee, Perth! Rhiconich, Sutherland!

Geogr. Distribution.—Galicia in Austria. Norway. Sweden.

Var. **compactum** *var. nov.* (Pl. LXXX, fig. 22.)

Smaller than the typical form, constriction deeper, sinus more narrowly linear, semicells oblong-elliptic; granules in 9 vertical and 3 or 4 horizontal series, vertical series upwardly divaricating, granules in the centre of the semicells larger than those near the sides.

Length 22 μ; breadth 22 μ; breadth of isthmus 6 μ; thickness 11 μ.

Scotland.—Harris, Outer Hebrides!

This variety differs from var. *pumilum* in the narrower sinus, in the more numerous granules, and in their unequal size.

161. **Cosmarium solidum** Nordst.
(Pl. LXXX, fig. 23.)

Cosmarium punctulatum Nordst. Desm. Spetsb. 1872, p. 26, t. 6, f. 1; et *β triquetrum* Nordst. l. c. f. 2 [not *C. punctulatum* Bréb. 1856].
C. solidum Nordst. in Botan. Notiser, 1887, p. 160; Freshw. Alg. N. Zeal. 1888, p. 48; Boldt, Desm. Grönland, 1888, p. 27; De Toni, Syll. Alg. 1889, p. 965; Nordst. Index Desm. 1896, p. 235; West & G. S. West, Alga-fl. Yorks. 1900, p. 72.
? *C. crenatum* Ralfs forma *a* Gutw. Flor. Glon. Okolic Lwowa, 1891, p. 41, t. 1, f. 12.
Ursinella solida Kuntze, Revis. gen. plant. 1891, p. 925.

Cells small, rather longer than broad or up to $1\frac{1}{3}$ times as long as broad, moderately deeply constricted, sinus linear; semicells subrectangular, basal angles obtuse, apical angles obtusely rounded, apex truncate and slightly 4-crenate-undulate, sides slightly convex and 5–7-crenate-undulate. Side view of semicell ovate-truncate, with a delicately undulate apex. Vertical view broadly elliptic, with the sides and poles slightly undulate. Cell-wall granulate, granules small and disposed in more or less regular vertical series.

Zygospore unknown.

Length 22–35 μ; breadth 21–28 μ; breadth of isthmus 10–12 μ; thickness 16–19·2 μ.

England.—Cronkley Fell and Carlton Bank, N. Yorks!

Geogr. Distribution.—Germany. Greenland. Spitzbergen. Nova Zembla.

This species is distinguished from *C. punctulatum* Bréb. by the form of its semicells and the different nature of its granulation.

162. **Cosmarium Etchachanense** Roy & Biss.
(Pl. LXXXI, fig. 1.)

Cosmarium Etchachanense Roy & Biss. Scott. Desm. 1894, p. 101, t. 1, f. 15; Nordst. Index Desm. 1896, p. 119; West & G. S. West, Alga-fl. Yorks. 1900, p. 72; Notes Alg. III, 1903, p. 75.

Cells small, about $1\frac{1}{4}$ times as long as broad, deeply constricted, sinus narrowly linear; semicells semicircular-elliptic, basal angles obtuse, sides convex and 6–7-undulate-crenate, apex subtruncate and very

obscurely undulate, with a single radiating series of about 4 granules within each marginal undulation, and in the centre with 6 or 7 vertical series of granules, 5 or 6 in each series. Side view of semicell rather broadly obovate-elliptic. Vertical view elliptic, ratio of axes about 1 : 1·7.

Zygospore unknown.

Length 38–40 μ; breadth 30–32 μ; breadth of isthmus 12–13 μ; thickness 17·5 μ.

England.—Langcliffe near Settle, Cowside Beck near Arncliffe, Horton-in-Ribblesdale, Penyghent, and Cowgill Wold Moss on Widdale Fell, W. Yorks!

Wales.—Moel Siabod, Llyn Idwal, and Llyn Cwlyd, Carnarvonshire!

Scotland.—Corrie Etchachan on Ben Macdhui, Aberdeen (*Roy & Bissett*). Winter Corrie, Clova Mts., Forfar!

Ireland.—Carrantuohill, Kerry!

This alpine Desmid will probably be found to have a much wider British distribution in the "corries" and springs high up on the mountains.

163. **Cosmarium Slewdrumense** Roy.
(Pl. LXXXI, fig. 6.)

Cosmarium Slewdrumense Roy, Desm. Alford District, 1890, p. 204; Roy & Biss. Scott. Desm. 1893, p. 174, t. 2, f. 19; Nordst. Index Desm. 1896, p. 235.

Cells small, a little longer than broad, deeply constricted, sinus linear; semicells somewhat oblong-elliptic, with a flattened base, sides 4-undulate, apex truncate and about 5-undulate, with a single radiating series of very minute granules within each undulation, in the centre with 4 compact vertical series of minute granules, 6 in each series. Vertical view elliptic, with the minute granules arranged in transverse lines.

Zygospore globose, furnished with somewhat distant, stout, attenuated spines (about 13 visible around the periphery).

Length 25 μ; breadth 22 μ; breadth of isthmus 7 μ; thickness 13 μ.

Wales.—Capel Curig, Carnarvonshire (*Roy*).

Scotland.—Caithness, Ross, Inverness, Nairn, Aberdeen, Kincardine, Forfar, Perth, Fife (*Roy & Bissett*).

This species appears to us to be very closely allied to *C. subcrenatum* Hantzsch. There are, however, certain slight differences, and as we have never observed any specimens which we could with certainty refer to Roy's species, for the present we keep the species separate.

164. **Cosmarium trachypleurum** Lund.

(Pl. LXXXI, figs. 2, 3.)

Cosmarium trachypleurum Lund. Desm. Suec. 1871, p. 27, t. 2, f. 12; Wolle, Desm. U. S. 1884, p. 73, t. 16, f. 26–29; De Toni, Syll. Alg. 1889, p. 973; Roy & Biss. Scott. Desm. 1894, p. 176; Nordst. Index Desm. 1896, p. 256; West & G. S. West, Alga-fl. Yorks. 1900, p. 72; Notes Alg. III, 1903, p. 10 (sep.); Freshw. Alg. Orkneys and Shetlands, 1905, p. 19.

C. trachypleurum Lund. a. *genuinum* Kirchn. Alg. Schles. 1878, p. 151; Racib. Desm. Nowe, 1889, p. 89.

Ursinella trachypleura Kuntze, Revis. gen. plant. 1891, p. 925.

Cells rather under medium size, $1\frac{1}{4}$ times as long as broad, deeply constricted, sinus narrowly linear with a slightly dilated extremity; semicells subreniform-oblong, lateral margins each with 5–7 acute granules, apex truncate (very slightly convex) and smooth, within the lateral margins and below the apex with a rather irregular double series of acute granules, with 7 large rounded granules in the centre, one central and 6 peripheral, and with minute punctulations between them. Side view of semicell circular, sides granulate, apex smooth. Vertical view elliptic, poles furnished with acute granules, and with three large rounded granules at the middle on each side (sometimes situated on a slight tumour). Cell-wall very delicately punctate between the granules. Chloroplasts axile, with two pyrenoids.

Zygospore unknown.

Length 46–50 μ; breadth 40–42 μ; breadth of isthmus 9·5–12·3 μ; thickness 26·5–28 μ.

England.—Pilmoor, N. Yorks!

Wales.—Llyn-y-cwm-ffynon, and Llanrhwchwyn near Llanwrst, Carnarvonshire!

Scotland.—Scotston Moor, Aberdeen (*Roy & Bissett*). West of Kirkwall, Orkneys! Bressay, Shetlands!

Geogr. Distribution.—Germany. Galicia in Austria. Poland. Sweden. Java (var.). Madagascar (var.). Australia (var.). United States.

The marginal granules of this species are acutely conical, whereas those in the centre of the semicells are flattened and rounded. There is sometimes a slight indication of a central tumour in the middle of each semicell.

Var. **minus** Racib. (Pl. LXXXI, figs. 4, 5.)

C. trachypleurum Lund. b. *minor* Racib. in Spraw. Kom. fizyj. Akad. Umiej. Krakow. xix, 1884, p. 11, t. 1, f. 5; Racib. Nonn. Desm. Polon. 1885, p. 73; Lütkem. Desm. Attersees, 1893, p. 552 [var. *minus*]; Roy & Biss. Scott. Desm. 1894, p. 177, t. 1, f. 13; West & G. S. West, Alg. N. Ireland, 1902, p. 38.

C. minus Racib. Desmidyja Ciastonia, 1892, p. 374.

Cells somewhat smaller and more compressed, semicells more oblong, with the acute marginal granules continued over the apex.

Length 31–34·5 μ; breadth 26·5–33 μ; breadth of isthmus 8·5–12 μ; thickness 18·5–20 μ.

Scotland.—Marsh between Loch Kinnord and Cambus O'May, Aberdeen; Durris, Kincardine (*Roy & Bissett*).

Ireland.—Lough Gartan, Donegal!

Geogr. Distribution.—Austria and Galicia. Poland. N. Russia. Sweden. Australia (a form).

165. **Cosmarium isthmochondrum** Nordst. (Pl. LXXXI, fig. 7.)

Cosmarium isthmochondrum Nordst. Norges Desm. 1873, p. 12, t. 1, f. 2; Wille, Norges Ferskv. Alg. 1880, p. 27; Boldt, Siber. Chlorophy. 1885, p. 106; Cooke, Brit. Desm. 1887, p. 114, t. 41, f. 9; De Toni, Syll. Alg. 1889, p. 1015; West, Alg. N. Wales, 1890, p. 290; Roy & Biss. Scott. Desm. 1894, p. 104; Nordst. Index Desm. 1896, p. 149; West & G. S. West, Alga-fl. Yorks. 1900, p. 72; Alg. N. Ireland, 1902, p. 38; Borge, Beiträge Alg. Schweden, 1906, p. 33.

? *C. suborbiculare* Wood in Proc. Acad. Nat. Sci. Philadelphia, 1869

(1870), p. 18; Freshw. Alg. N. Amer. 1874, p. 129, t. 21, f. 9; Wolle, Desm. U. S. 1884, p. 78, t. 24, f. 24; De Toni, Syll. Alg. 1889, p. 999.
C. binodulum Reinsch, Contrib. Alg. et Fungi, 1875, p. 83, t. 18, f. 5; De Toni, Syll. Alg. 1889, p. 1034.
Ursinella binodula Kuntze, Revis. gen. plant. 1891, p. 924.
U. isthmochondra Kuntze, l. c. p. 925.
? *U. suborbicularis* Kuntze, l. c. p. 925.

Cells small, about $1\frac{1}{6}$ times as long as broad, deeply constricted, sinus narrowly linear; semicells semicircular-elliptic, basal angles obtuse and furnished with a papilla, sides convex and furnished with 4 or 5 acute granules, apex subtruncate (very slightly convex) and smooth, with a single series of 4 minute granules within each lateral margin and two larger granules within the median part of the apex, with a large granule immediately above the isthmus, and with one or two scrobiculations in the centre of the semicell. Side view of semicell circular, with a granule on each side of the apex and one just above the isthmus on each side. Vertical view elliptic, sides granulate, with two larger granules at the middle on each side, poles somewhat pointed. Chloroplasts axile, each with two pyrenoids.

Zygospore unknown.

Length 30–35 μ; breadth 27–30 μ; breadth of isthmus 7·5–11 μ; thickness 18–19 μ.

England.—Near Bowness, Westmoreland (*Bissett*). Near Keighley and Cautley Spout, W. Yorks! Near Jervaulx Abbey and Pilmoor, N. Yorks!

Wales.—Capel Curig, Carnarvonshire!

Scotland.—Loch Ruthven, Inverness; Aberdeen; Bishop's Dam in Strachan, Kincardine; Tannadice and Clova Tableland, Forfar; Durdie and near Fowlis Wester, Perth; Glen Coe, Argyll (*Roy & Bissett*).

Ireland.—Lough Machugh, Donegal!

Geogr. Distribution.—Norway. Sweden. Madagascar (var.). Brazil (var.). Paraguay (var.).

Var. **pergranulatum** West & G. S. West.
(Pl. LXXXI, fig. 8.)

C. isthmochondrum Nordst. var. *pergranulatum* West & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 21, t. 1, f. 20.

Semicells with less distinct marginal granules; central scrobiculations absent; granules within the lateral margins more numerous.

Length 37·5 μ; breadth 31·5 μ; breadth of isthmus 7·5 μ; thickness 20 μ.

Scotland.—Near Kirkwall, Orkneys!

166. **Cosmarium jenisejense** Boldt.

(Pl. LXXXI, fig. 9.)

Cosmarium jenisejense Boldt, Siber. Chlorophy. 1885, p. 107, t. 5, f. 13; De Toni, Syll. Alg. 1889, p. 1049; West, Danish Algæ, 1891, p. 420; Roy & Biss. Scott. Desm. 1894, p. 104; Nordst. Index Desm. 1896, p. 150.

Ursinella jenisejensis Kuntze, Revis. gen. plant. 1891, p. 924.

Cells small, about as long as broad, deeply constricted, sinus linear and slightly open outwards; semicells oblong-elliptic, with the base more flattened than the apex, each lateral margin with about 9 marginal granules, apex truncate and smooth, cell-wall within the margins granulate, the granules in the centre of the semicells being rather more distinct. Side view of semicell circular. Vertical view elliptic, granules arranged in transverse series across the poles, with a small but prominent 3-granulate tumour at the middle of each side.

Zygospore unknown.

Length 36 μ; breadth 33·7–35 μ; breadth of isthmus 15 μ; thickness 22·5–23·5 μ.

Scotland.—Cairngorm, Inverness (*Roy & Bissett*).

Geogr. Distribution. — Galicia in Austria (var.). Denmark. Siberia. India.

C. jenisejense is very closely allied to *C. punctulatum* and its varieties, amongst which it should perhaps be placed. It differs from *C. punctulatum* in its more rounded semicells, and in the small but projecting central inflation. We have for the present retained it as a species, as it will be necessary to carefully examine a number of typical specimens in order to discover its true relationships. We are personally acquainted with this species only from the examination of a few half-cells observed in material collected in Denmark.

167. **Cosmarium sphalerostichum** Nordst.

(Pl. LXXXI, figs. 12–14.)

Cosmarium sphalerostichum Nordst. Desm. Ital. 1876, p. 29, t. 12, f. 3; Cooke, Brit. Desm. 1887, p. 111, t. 42, f. 6; Wolle, Freshw. Alg. U. S. 1887, p. 31, t. 57, f. 26–27; Boldt, Desm. Grönland, 1888, p. 27; De Toni, Syll. Alg. 1889, p. 1034; West, Alg. N. Wales, 1890, p. 290; Alg. W. Ireland, 1892, p. 157; Alg. Engl. Lake Distr. 1892, p. 728; Roy & Biss. Scott. Desm. 1894, p. 175; Nordst. Index Desm. 1896, p. 237; West & G. S. West, Alg. S. England, 1897, p. 489; Alga-fl. Yorks. 1900, p. 72; Alg. N. Ireland, 1902, p. 38; Freshw. Alg. Orkneys and Shetlands, 1905, p. 20; Borge, Beiträge Alg. Schweden, 1906, p. 32.
Ursinella sphalerosticha Kuntze, Revis. gen. plant. 1891, p. 925.

Cells very small, a little longer than broad, deeply constricted, sinus narrow and linear; semicells subreniform-trapeziform with a much flattened base, basal angles subrectangular, apex truncate and smooth, lateral margins convex, furnished with 4 or 5 rather acute granules; granules on the surface of the semicell variable in number and disposition, but commonly in transverse (2 or 3) and vertical (5 or 6) series, the series being very frequently incomplete. Side view of semicell circular. Vertical view elliptic, ratio of axes about 1 : 1·3, margin granulate, granules at the poles acute, those at the middle on each side rounded and slightly larger, generally with one series of about 4 granules within each pole. Chloroplasts axile, each with one pyrenoid.

Zygospore globose or subglobose, black and smooth.

Length 15·5–20 μ; breadth 13–15·5 μ; breadth of isthmus 5–6 μ; thickness 10–12 μ; diam. zygosp. 18–20 μ.

England.—Cumberland! Westmoreland! Lancashire! W. and N. Yorks! Surrey! Wilts! Devon! Cornwall!

Wales.—Yr Orsedd, near Bethesda, Llyn Padarn, Llyn Bochlwyd, Capel Curig, Llyn Cwlyd, Snowdon, and Llyn Gwynant, Carnarvonshire! Radnor!

Scotland.—Morven, Aberdeen; Canlochan, Forfar (*Roy & Bissett*). Clova Mts., Forfar! Ben Nevis, Inverness! Near Lerwick and near Scalloway, Shetlands!

Ireland.—Donegal! Mayo! Galway! Kerry! Down!

Geogr. Distribution.—Switzerland. Italy. Portugal. Sweden. Greenland. United States. Brazil.

C. sphalerostichum is largely an alpine Desmid, occurring more frequently on dripping rocks and in small boggy mountain streams than in other situations. It is not infrequent in the mountainous areas of the British Islands, and it also occurs on some of the old heaths. It stands perhaps nearest to *C. orthostichum* var. *pumilum*, but is distinguished by its smooth apices, its acute lateral granules, and by the much greater irregularity in the general granulation.

168. **Cosmarium geminatum** Lund.

(Pl. LXXXI, fig. 15.)

Cosmarium geminatum Lund. Desm. Suec. 1871, p. 31, t. 6, f. 8; Wille, Sydamerik. Algfl. 1884, p. 15; De Toni, Syll. Alg. 1889, p. 992; Eichler in Pamietnik Fizyj. Warszaw. x, 1890, p. 87; Nordst. Index Desm. 1896, p. 128.

Ursinella geminata Kuntze, Revis. gen. plant. 1891, p. 924.

Cells small, as long as broad, very deeply constricted, sinus acute-angled and slightly open; semicells oblong and truncately rounded at each lateral extremity, apex very widely subtruncate, ventral margin subconvex, delicately granulate-dentate all round the external margin, also granulate within the margin, in the centre with a pair of very small quadrifid (4-granulate) tumours transversely disposed. Side view of semicell circular-hexagonal, apex truncate, and on each side with two denticulations and a median emarginate wart. Vertical view elliptic in outline, at and near the poles sinuate-denticulate, with a pair of small emarginate warts at the middle on each side, and with two series of granules within the margin; in the centre smooth.

Zygospore unknown.

Length 18–27 μ; breadth 20–28 μ; breadth of isthmus 8–8·7 μ; thickness 12–17·5 μ.

Wales.—Capel Curig, Carnarvonshire!

Geogr. Distribution.—Germany. Galicia in Austria. Poland. Sweden. Central China (var.). Japan. Brazil.

This small species is one of the most characteristic and at the same time one of the rarest of British Desmids.

169. **Cosmarium trachydermum** West & G. S. West. (Pl. LXXXII, fig. 1.)

Cosmarium trachydermum West & G. S. West, Alg. Madag. 1895, p. 64, t. 6, f. 26; Nordst. Index Desm. 1896, p. 256; West & G. S. West, Alga-fl. Yorks. 1900, p. 73.

Cells rather under medium size, a little longer than broad, deeply constricted, sinus somewhat open with an obtuse extremity; semicells elliptic-oblong, sides rounded, apex truncate or subtruncate. Side view of semicell subcircular. Vertical view elliptic, ratio of axes about 1 : 1·7. Cell-wall evenly granulate all over, granules very small, without any definite arrangement, 29–30 visible at the margin. Chloroplasts axile, with two pyrenoids.

Zygospore unknown.

Length 40·5 μ; breadth 36 μ; breadth of isthmus 16 μ; thickness 21 μ.

England.—Cowgill Wold Moss, Widdale Fell, W. Yorks!

Geogr. Distribution.—Madagascar.

C. trachydermum has no near relatives among British species, the rounded semicells and open sinus at once distinguishing it from all forms of *C. punctulatum*.

170. **Cosmarium sphæroideum** West. (Pl. LXXXII, figs. 2–4.)

Cosmarium sphæroideum West, Alg. W. Ireland, 1892, p. 153, t. 21, f. 8; Nordst. Index Desm. 1896, p. 237; West & G. S. West, Alg. N. Ireland, 1902, p. 37.

Cells of medium size, about $1\frac{1}{2}$ times as long as broad, deeply constricted, sinus narrow and short, but not completely closed; semicells subcircular-obovate, with the widest part about two-thirds the distance from the base, basal part truncately flattened, lower parts of sides slightly convex and diverging upwards, upper parts very broadly rounded, apex in the middle truncate and not uncommonly very faintly retuse.

Side view of semicell very broadly elliptic. Vertical view broadly elliptic, ratio of axes about 1 : 1·2. Cell-wall uniformly granulate ; granules large and flattened, causing the margin of the semicells to appear undulate, about 22–24 visible at the periphery of one semicell, disposed in indistinct oblique series (about 11 visible in front view), sometimes almost entirely without any regularity of arrangement, at the central part of the apex often reduced. Chloroplasts axile, with two pyrenoids.

Zygospore unknown.

Length 60–63 μ ; breadth 38–40 μ ; breadth of isthmus 15–20 μ ; thickness 27–31 μ.

England.—Strensall Common, N. Yorks!

Scotland. — Rhiconich, Sutherland! Lewis and Harris, Outer Hebrides!

Ireland.—Near Lough Glentornan, Donegal! Arderry Lough, Galway! Cromagloun, Torc Mt., Glen Caragh, and Castletown, Kerry!

This species appears to be principally confined to the bogs of the old rocks of the western British areas. It occurs in association with *Xanthidium Smithii*, *Euastrum crassum* var. *scrobiculatum*, *Penium adelochondrum*, *Cosmarium commissurale* var. *crassum*, and many other rare Desmids. It should be compared with *Cosmarium Logiense* Bissett and *C. prægrande* Lund., from both of which species it is easily distinguished.

171. **Cosmarium Wittrockii** Lund.

(Pl. LXXVIII, fig. 19.)

Cosmarium Wittrockii Lund. Desm. Suec. 1871, p. 31, t. 3, f. 14; Kirchn. Alg. Schles. 1878, p. 152; Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 44; Norges Ferskv. Alg. 1880, p. 24; Boldt, Siber. Chlorophy. 1885, p. 108; ? Benn. Freshw. Alg. Engl. Lake Distr. 1886, p. 10, t. 1, f. 15; Cooke, Brit. Desm. 1887, p. 118, t. 42, f. 8; De Toni, Syll. Alg. 1889, p. 964; Schmidle, Beitr. Algenfl. Schwarzwald. u. Rheineb. 1893, p. 99, t. 4, f. 23; Roy & Biss. Scott. Desm. 1894, p. 177; Gutw. Flor. Glon. Okolic Tarnapola, 1894, p. 87, t. 3, f. 17; Nordst. Index Desm. 1896, p. 272.

Ursinella Wittrockii Kuntze, Revis. gen. plant. 1891, p. 926.

Cosmarium Wittrockii Lund. var. *Schmidlei* Borge, Sverig. Chlorophy. II, p. 16 [= *C. Wittrockii* figured by Schmidle, l. c. 1893].

C. pseudorthopunctatum West & G. S. West, Freshw. Chlorophy. Koh Chang, 1901, p. 89, t. 2, f. 12–13.

Cells very small, about as long as broad or a little longer, deeply constricted, sinus open and subrectangular; semicells subelliptic, ventral margin very strongly convex, apex slightly convex, or broadly truncate and straight, lateral angles rounded or acutely rounded. Side view of semicell circular. Vertical view elliptic, poles often slightly pointed. Cell-wall very finely granulate, granules arranged in regular longitudinal and transverse series (about 9 longitudinal and 5–6 transverse), the longitudinal sometimes more distinct than the transverse series. Chloroplasts axile, with one central pyrenoid.

Zygospore unknown.

Length 18–24 μ; breadth 15–23·5 μ; breadth of isthmus 5·7–9 μ; thickness 12–12·2 μ.

England.—Enbridge Lake, Hants (*Roy*). Cornwall (*Bennett*).

Scotland.—Near Heugh-head, Aboyne, Aberdeen (*Roy & Bissett*).

Geogr. Distribution.—Germany. Galicia in Austria. Norway. Sweden. Bornholm. Denmark. Nova Zembla. Siberia. Siam. Patagonia (var.).

The degree of flattening of the apices of the semicells, and also the precise disposition of the granules, is subject to variation. In some forms the apices are almost straight, whereas in others they are convex, although frequently flattened in the middle. The vertical series of granules are always strongly evident, but the horizontal series are often very indefinite. Considering these variations, we find it impossible to regard either Borge's var. *Schmidlei* or *Cosmarium pseudorthopunctatum* as forms worthy of separate mention.

172. **Cosmarium synthlibomenum** West.

(Pl. LXXXII, figs. 5–7.)

Cosmarium synthlibomenum West, Alg. W. Ireland, 1892, p. 154, t. 21, f. 11 [figures poor and not very accurate]; Nordst. Index Desm. 1896, p. 250; West & G. S. West, Alg. N. Ireland, 1902, p. 42.

Cells minute, about as long as broad, moderately deeply constricted, sinus widely open with an obtuse

extremity; semicells compressed-elliptic and sparsely granulate, granules acute and very minute, about 8 showing at the margin of a semicell and 5–7 widely and irregularly scattered over the surface. Side view of semicell subcircular, with about 6 marginal granules. Vertical view elliptic, ratio of axes about 1 : 1·7, with about 9 (6–10) marginal granules. Chloroplasts axile, one in each semicell, each with two pyrenoids (sometimes with only one?).

Zygospore unknown.

Length 12–13 μ; breadth 11–13 μ; breadth of isthmus 7·5–9 μ; thickness 6·5–8 μ.

Ireland.—Pool near Lough Glentornan, Donegal! Small *Sphagnum*-pool, Ballynahinch, Galway!

We have only observed this minute species twice, and on each occasion among the submerged *Sphagnum* of a small boggy pool. We pointed out in 1902 ('Alg. N. Ireland,' p. 42) that the original description and figures were not very accurate. The granulation is very delicate and easily overlooked on the younger semicells. The granules themselves are pointed, and very sparingly and irregularly scattered. The structure of the chloroplasts can only be ascertained with difficulty, and although many specimens possess two pyrenoids in each semicell, others apparently possess only one.

C. synthlibomenum should be compared with *C. orthostichum* var. *pumilum*, from which it is distinguished by its much smaller size, its more delicate granulation, and by its fewer and irregularly scattered granules of conical shape. A similar type of granulation appears to occur in a Desmid described by Schmidle from the Alps as *Dysphinctium sparsipunctatum* (*vide* Schmidle, 'Beiträge alp. Alg.' 1895, p. 348, t. 15, f. 1–6), only it is of a still more delicate character, and frequently merely a punctulation of the cell-wall. The granules of *C. synthlibomenum* are of a definite conical shape, and the cell-outline is quite constant in character.

173. **Cosmarium protractum** (Näg.) De Bary.

(Pl. LXXXII, fig. 8; Pl. XCIV, figs. 4, 5.)

Euastrum (*Cosmarium*) *protractum* Näg. Gatt. einzell. Alg. 1849, p. 119, t. 7A, f. 4.

Cosmarium protractum (Näg.) De Bary, Conj. 1858, p. 72; Arch. in Pritch. Infus. 1861, p. 733; Rabenh. Flor. Europ. Alg. III, 1868, p. 172; De Toni, Syll. Alg. 1889, p. 1028; Anderss. Sverig. Chlor. 1890, p. 17; Roy & Biss. Scott. Desm. 1894, p. 172; Nordst. Index Desm. 1896, p. 206; West & G. S. West, Some Desm. U. S. 1898, p. 309; Hirn, Desm. Finnland, 1903, p. 11, t. 1, f. 10; Larsen, Freshw. Alg. E. Greenland, 1904, p. 87.

Didymidium (*Cosmarium*) *protractum* Reinsch, Algenfl. Frank. 1867, p. 120 [*a majus* et *β minus*].

Cosmarium ornatum Ralfs var. *protractum* Wolle, Desm. U. S. 1884, p. 82, t. 49, f. 22 [figure poor]; Borge, Sverig. Chlorophy. II, 1895, p. 20.

C. ornatum var. *minor* Wolle, l. c. t. 17, f. 29 [figure poor].

C. ornatum var. *polonicum* Racib. Nonn. Desm. Polon. 1885, p. 72, t. 11, f. 3 [figure poor]; Gutw. Flor. Glon. Okolic Tarnapola, 1894, p. 99.

C. Turpinii Bréb. var. *polonicum* (Racib.) Schmidle, Lappmark Süsswasseralgen, 1898, p. 39.

Cells somewhat small, about as long as broad or slightly longer, very deeply constricted, sinus narrowly linear with a slightly dilated extremity; semicells three-lobed, with a subrectangular incision between the apical lobe and each lateral lobe, lateral lobes rather narrow and rounded, apical lobe short, with rounded angles and a slightly retuse apex; lobes granulate, granules in more or less distinct decussating oblique series, becoming reduced in size towards the large granulated central protuberance, the granules of which are arranged in concentric rings. Side view of semicell ovate, with a protuberance on each side near the base. Vertical view rather narrowly elliptic-oblong, with a granulated protuberance at the middle on each side, apex of semicell rectangular-oblong with rounded angles. Chloroplasts axile, with two pyrenoids.

Zygospore unknown.

Length 34–45 μ; breadth 33–42 μ; breadth of apex 16–19 μ; breadth of isthmus 9–12 μ; thickness 19·5–24 μ.

England.—Sutton Park, Warwickshire!

Scotland.—Tableland above the head of Glen Callater, Aberdeen (*Roy & Bissett*).

Geogr. Distribution.—Germany. Galicia in Austria. Poland. Norway. Sweden. Finland. United States.

This species is well characterized by its strongly projecting apex, which gives the semicells a three-lobed appearance. In

the middle of each semicell there is a large central protuberance with concentrically arranged granules, and the general granulation of the lobes becomes slightly reduced towards this central tumour. The apex of the median lobe is slightly retuse, but there is no reduction of the granulation at this part. Nägeli's original figures of this Desmid are most inaccurate, especially as regards the granulation. Although that author clearly shows the presence of the central protuberance in his figure of the vertical view, he does not show the slightest indication of it in his figure of the empty semicell. We have examined many British and North American specimens of this species, and have never yet seen one without the central protuberance with its concentrically arranged granules.

There is no doubt whatever that *C. ornatum* var. *protractum* Wolle, *C. ornatum* var. *minor* Wolle, and *C. ornatum* var. *polonicum* Racib. are forms of *C. protractum* (Näg.) De Bary, very indifferently described and figured, insufficient attention having been given to accuracy in depicting the granulation.

C. protractum exhibits certain variations in the apical lobe of the semicells. This lobe is sometimes relatively short and slightly constricted at the base, whereas in its more usual condition it is very gradually attenuated upwards. These modifications can be observed in different individuals in the same collection.

174. **Cosmarium Corbula** Bréb.

(Pl. LXXXII, figs. 9–11.)

Cosmarium Corbula Bréb. Liste Desm. 1856, p. 131, t. 1, f. 13; Arch. in Pritch. Infus. 1861, p. 734; Cooke, Brit. Desm. 1887, p. 107, t. 43, f. 9; De Toni, Syll. Alg. 1889, p. 1054; Roy & Biss. Scott. Desm. 1894, p. 44, t. 2, f. 18; Nordst. Index Desm. 1896, p. 82; West & G. S. West, Alg. S. England, 1897, p. 490; Alga-fl. Yorks. 1900, p. 76; Alg. N. Ireland, 1902, p. 39; Freshw. Alg. Orkneys and Shetlands, 1905, p. 20.
C. Sportella Bréb. b. *Corbula* Rabenh. Flor. Europ. Alg. III, 1868, p. 169.
Ursinella Corbula Kuntze, Revis. gen. plant. 1891, p. 924.

Cells rather small, about as broad as long (or very slightly broader), deeply constricted, sinus very narrowly linear; semicells broadly pyramidate-trapeziform, basal angles rounded, upper parts of sides slightly retuse just under the apex, apex broadly truncate and straight, apical angles very slightly emarginate and bigranulate. Cell-wall granulate, granules restricted

to the basal angles and the apical region; with about 3 oblique series of granules across each basal angle (5 visible at the margin), and with about 6 short oblique series within the apex (5–6 visible along the flat apical margin); in the centre of the semicells with a tumour furnished with a ring of 8 granules surrounding a larger central one. Side view of semicell subcircular with an inflation on each side towards the base. Vertical view elliptic with a prominent 3-granulate tumour at the middle on each side, poles granulate. Chloroplasts axile, with one pyrenoid.

Zygospore globose, furnished with rather delicate processes or spines, dilated at the base, furcate-emarginate (sometimes trifurcate) at the apex, and not infrequently bent.

Length 31–33 μ; breadth 31·5–35 μ; breadth of isthmus 10–10·4 μ; thickness 20–22·5 μ; diam. zygosp. without spines 32 μ, with spines 61 μ.

England. — Cocket Moss near Giggleswick, W. Yorks! Leicestershire (*Roy*). Epping Forest, Essex! Esher West-end Common, Surrey (very abundant in 1893–4)! Enbridge Lake, Hants. (*Roy*). Near St. Just, Cornwall!

Wales.—Near Pen-y-gwryd and Capel Curig, Carnarvonshire (*Roy*).

Scotland.—Ross, Inverness, Aberdeen, Kincardine (with zygospores from near Crathes), Forfar, Perth (*Roy & Bissett*). Kirkwall, Orkneys!

Ireland.—Lough Gartan, Donegal! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Silesia in Austria. United States.

This characteristic species is very local in its distribution. On two occasions we obtained it in quantity in ditches on Esher West-end Common, Surrey, amongst various filamentous Conjugates. Messrs. Roy and Bissett were the first to point out its decisive characters and to figure the zygospore. Joshua had previously mentioned (1882) the occurrence of the zygospore near Cirencester, Gloucestershire, but this requires confirmation.

175. **Cosmarium Sportella** Bréb.

(Pl. LXXXII, figs. 12, 13.)

Cosmarium Sportella Bréb. in Kütz. Spec. Algar. 1849, p. 176 [description bad]; Liste Desm. 1856, p. 130, t. 1, f. 12; Arch. in Pritch. Infus. 1861, p. 734; Rabenh. Flor. Europ. Alg. III, 1868, p. 169; Nordst. Desm. Ital. 1876, p. 28; Nordst. in Wittr. & Nordst. Alg. Exsic. 1877, no. 78; fasc. 21, 1889, p. 41; Wolle, Desm. U. S. 1884, p. 83, t. 49, f. 28–30 [figures very bad]; Cooke, Brit. Desm. 1887, p. 107, t. 41, f. 6 [figures inaccurate]; De Toni, Syll. Alg. 1889, p. 1053; Roy & Biss. Scott. Desm. 1894, p. 175; Nordst. Index Desm. 1896, p. 240; West & G. S. West, Alg. S. England, 1897, p. 490; Alga-fl. Yorks. 1900, p. 75; Alg. N. Ireland, 1902, p. 39.

Ursinella Sportella Kuntze, Revis. gen. plant. 1891, p. 925.

Cells rather under medium size, slightly longer than broad, very deeply constricted, sinus narrowly linear with a slightly dilated extremity; semicells shortly truncate-pyramidate, basal angles broadly rounded, upper parts of sides just below the apex very slightly (almost imperceptibly) hollowed, upper angles obtuse, apex very faintly outstanding, broadly truncate and straight. Cell-wall granulate, about 6–7 granules visible on each lateral margin (including the basal angle), upper angles strongly bigranulate (almost emarginate), apex smooth or with 4–5 small marginal granules, granules within the margins irregularly scattered and gradually reduced in size towards the centre, with a group of about 7 larger granules in the centre of the semicells situated on a very slight central tumour (sometimes scarcely evident and the granules themselves much reduced); with minute punctulations between the granules. Side view of semicell ovate-elliptic with a rounded apex. Vertical view elliptic, with an almost imperceptible 3-granulate tumour at the middle on each side. Chloroplasts axile, with two pyrenoids.

Zygospore globose and furnished with spines, shortly 2–3-furcate at the apex and each surrounded by a corona of small teeth at the base.

Length 45–49 μ; breadth 42–45 μ; breadth of apex 23–25·5 μ; breadth of isthmus 13–14·5 μ; thickness 23–24 μ; diam. zygosp. without spines about 50 μ.

England.—Near Bowness, Westmoreland (*Bissett*). Cowside Beck near Arncliffe, W. Yorks! Epping Forest, Essex!

Wales.—Capel Curig, Carnarvonshire (*Roy*). Holyhead (in pond)!

Scotland.—Ross, Inverness, Aberdeen, Kincardine (zygospores from Muchalls), Forfar, Perth, Stirling, Arran, Wigtown (*Roy & Bissett*).

Ireland.—Errigal, Donegal! Derryclare Lough, Galway! Dublin and Wicklow (*Archer*). Slievecommedagh and Slieve Donard (up to 2000 ft.), Down!

Geogr. Distribution.—France. Italy. Sweden. Bornholm. United States.

There is a considerable resemblance between *C. Sportella* and *C. Corbula*, but the former is larger and differently ornamented. The granules of *C. Sportella* are irregularly disposed and the granulated tumour in the centre of the semicells is relatively smaller; in fact, this tumour is sometimes almost wanting and the granules on it are much reduced.

We have never met with any specimens with a dilated apex such as is indicated in Brébisson's original figure, but this figure, like many others by the same author, is most wretched. The zygospores have been obtained by Nordstedt in Sweden and by Messrs. Roy and Bissett in Scotland.

Var. **subnudum** *var. nov.* (Pl. LXXXII, fig. 14.)

Cells proportionately longer (almost $1\frac{1}{4}$ times as long as broad); semicells more pyramidate, basal angles not quite so rounded, central granules and tumour entirely absent.

Length 51 μ; breadth 41 μ; breadth of apex 22 μ; breadth of isthmus 14·5 μ.

England.—Ogden Clough, W. Yorks!

This variety occurred in abundance among mosses on dripping rocks. As in the type, the cell-wall is finely punctate.

176. **Cosmarium vexatum** West.

(Pl. XCII, fig. 4.)

Cosmarium vexatum West, Alg. Engl. Lake District, 1892, p. 727, t. 9, f. 33; Nordst. Index Desm. 1896, p. 270.

Cells under medium size, a little longer than broad, very deeply constricted, sinus narrowly linear with a dilated extremity; semicells pyramidate-truncate, basal and upper angles obtuse, sides convex and undulate, with 6–7 undulations gradually increasing in size from the basal angle to the upper angle, apex truncate, straight or very slightly subundulate, within the margin granulate, granules rather sparse and subconcentrically arranged (sometimes with a very indefinite radial arrangement), gradually diminishing in size towards the smooth central area. Side view of semicell ovate-circular or subcircular. Vertical view oblong-elliptic, poles granulate, with a wide and smooth tumour at the middle on each side, ratio of axes about 1 : 2. Chloroplasts axile, with two pyrenoids.

Zygospore unknown.

Length 41–43 μ; breadth 36–38 μ; breadth of isthmus 13·5–14 μ; crass. 20–21 μ.

England.—Ambleside, Westmoreland!

This Desmid occurred in considerable abundance among various Algæ in a horse-trough, and also in an adjacent ditch, at Ambleside. It stands nearest to *C. Quasillus* Lund., especially in the gradual increase in size of the lateral undulations from base to apex, and as in that species the apex projects, but in a much less marked degree. *C. vexatum* differs, however, in its smaller size, in the form of its semicells, in the smooth and less prominent central inflation, and in the general form of its vertical view.

Schmidle has described a "var. *concavum*" of this species from Germany ('Alg. Geb. Oberrheins,' 1893, p. 550, t. 28, f. 21), but apart from its somewhat larger size it does not appear to differ in any essential point from the British form. He describes the sides as concave, but figures them convex. There is a very slight hollow on each side below the apex in all the British specimens, thus causing the apex to project very slightly.

A form of *C. vexatum* was observed from near Cockermouth, Cumberland (Pl. XCII, fig. 5), in which the semicells were less pyramidate, and the increase in size of the lateral undulations from base to apex was not so strongly marked. The central area was sparsely punctate.

177. **Cosmarium Quasillus** Lund.

(Pl. XCII, fig. 3.)

Cosmarium Quasillus Lund. Desm. Suec. 1871, p. 29, t. 3, f. 10; Wolle, see Desm. U. S. 1884, p. 84, t. 17, f. 13–15; De Toni, Syll. Alg. 1889, p. 1020; Roy & Biss. Scott. Desm. 1894, p. 173; Borge, Süssw. Chlorophy. Archang. 1894, p. 29; Gutw. Flor. Glon. Okolic Tarnapola, 1894, p. 98; Nordst. Index Desm. 1896, p. 218; West & G. S. West, Alg. S. England, 1897, p. 490.

C. irregulare Wolle in Bull. Torr. Bot. Club, 1877, p. 186 [*vide* Wolle, Desm. U. S. 1884, p. 85].

Ursinella Quasillus Kuntze, Revis. gen. plant. 1891, p. 925.

Cells of medium size, hexagonal in general outline, a little longer than broad, very deeply constricted, sinus narrowly linear with a dilated apex; semicells trapeziform or pyramidate-truncate, rather suddenly narrowed from a broad flat base, basal angles obtuse and minutely undulate-dentate, lateral margins undulate with the undulations increasing in size upwards, apex a little produced, truncate and faintly biundulate, apical angles obtuse, in the centre with a granulated tumour, the granules being of large size and disposed in subconcentric series; cell-wall granulate, granules arranged in radiating and subconcentric series, with a small smooth space around the central tumour. Side view of semicell ovate, with a verrucose tumour on each side towards the base, apex rounded. Vertical view rather narrowly elliptic, with a verruculose tumour at the middle on each side, poles somewhat pointed. Chloroplasts axile, with two pyrenoids.

Zygospore unknown.

Length 66–80 μ; breadth 60–74 μ; breadth of isthmus 17·5–21 μ; thickness 44 μ.

England.—Esher West-end Common and Wimbledon Common, Surrey!

Scotland.—Near Longside, Aberdeen; Alva Glen, Stirling (*Roy & Bissett*).

Geogr. Distribution.—Germany (var.). Galicia in Austria. Sweden. Bornholm. Denmark. N. Russia. Spitzbergen. United States. Argentina (var.).

C. Quasillus has something of the general habit and appearance of *C. Turpinii*, but differs in its relatively greater width, in its undulate margins, in the arrangement of its granules, and in the form of the central protuberance.

178. **Cosmarium Turpinii** Bréb.

(Pl. LXXXII, figs. 16, 17; Pl. LXXXIII, fig. 1.)

Cosmarium Turpinii Bréb. Liste Desm. 1856, p. 127, t. 1, f. 11 [description and figure poor and imperfect]; Arch. in Pritch. Infus. 1861, p. 733; Rabenh. Flor. Europ. Algar. III, 1868, p. 172; Lund. Desm. Suec. 1871, p. 29, t. 3, f. 9; Delp. Desm. subalp. 1877, p. 23, t. 8, f. 40–43; Boldt, Siber. Chlorophy. 1885, p. 105; Cooke, Brit. Desm. 1887, p. 106; Nordst. Bornh. Desm. 1888, p. 193; De Toni, Syll. Alg. 1889, p. 1019; Borge, Bidr. Siber. Chlor. 1891, p. 13; Nordst. Index Desm. 1896, p. 265; West & G. S. West, Alg. S. England, 1897, p. 490; Some Desm. U. S. 1898, p. 307; Alga-fl. Yorks. 1900, p. 76; Alg. N. Ireland, 1902, p. 39; Larsen, Freshw. Alg. E. Greenland, 1904, p. 90; West & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 20; Comp. Study Plankton Irish Lakes, 1906, p. 85; Borge, Beiträge Alg. Schweden, 1906, p. 40.

C. Turpinii Bréb. var. *Lundellii* Gutw. in Spraw. Kom. fizyj. Akad. Umiej. Krakow, 1884, p. 133; Racib. Nonn. Desm. Polon. 1885, p. 74 [b. *Lundellii* 1. *genuina*]; Gutw. Wahr. d. Priorität, 1890, p. 71; West, Add. Alg. W. Yorks. II, 1891, p. 246; Gutw. Flor. Glon. Okolic Lwowa, 1891, p. 62, t. 3, f. 1; West, Alg. W. Ireland, 1892, p. 155; Alg. Engl. Lake District, 1892, p. 727; Roy & Biss. Scott. Desm. 1894, p. 177.

C. Turpinii Bréb. a. *Brébissonii* Racib. in Spraw. Kom. fizyj. Akad. Umiej. Krakow, 1884, p. 11 (sep.).

C. Turpinii Bréb. forma *gallica* Boldt, Desm. Grönland, 1888, p. 24.

Ursinella Turpinii Kuntze, Revis. gen. plant. 1891, p. 926.

Cosmarium Botrytis (Bory) Menegh. var. *emarginato-constrictum* Lemm. Klebahn & Lemm. Vorarbeit. Flor. Plön. Seengebeites, 1895, p. 57 (c. fig. 10).

C. emarginato-constrictum Lemm. Zweiter Beitr. Algenfl. Plöner Seen. 1896, p. 171.

Cells of medium size, a little longer than broad, very deeply constricted, sinus narrowly linear with a slightly dilated extremity, somewhat open outwards; semicells pyramidate-trapeziform, rapidly narrowed from a broad base, basal angles rounded, sides very slightly concave (more especially in the upper part), apical angles obtuse, apex very slightly retuse; cell-wall densely granulate, granules irregularly disposed, 36–40 visible at the margin, slightly reduced in size

towards the centre, where there is a small ill-defined clear space surrounding a pair of closely adjacent tumours; central tumours rather small and covered with large irregularly arranged granules, those of one tumour merging with those of the other. Side view of semicell ovate, with a rounded apex and a granulate inflation on each side near the base. Vertical view rather narrowly elliptic, with a pair of adjacent granulate tumours at the middle on each side. Chloroplasts axile, with two pyrenoids.

Zygospore unknown.

Length 60–77 μ; breadth 50–67 μ; breadth of apex 21·5–25 μ; breadth of isthmus 14–20 μ; thickness 29–38 μ.

England. — Borrowdale and near Cockermouth, Cumberland! Westmoreland! Lancashire! W. and N. Yorks! Leicestershire (*Roy*). Lincolnshire! Norfolk! Cambridgeshire! Warwickshire! Surrey! Hants! Devon! Cornwall!

Wales.—Llyn Cwlyd!, Glyder Fawr (*Roy*), and near Bettws-y-Coed!, Carnarvonshire. Dolgelly, Merioneth!

Scotland.—Coul and Loch Kinnellan, Ross; Sand Loch, Collieston, Howford, Inverurie, and Glen Cairn, Aberdeen; Rannoch, Perth; near Kingshouse, Argyll (*Roy & Bissett*). Plankton of Loch Asta, Shetlands!

Ireland.—Donegal! Mayo! Kerry! Wicklow! Londonderry! Armagh! In the lake-plankton of Kerry! Plankton of Lough Neagh and Lough Beg!

Geogr. Distribution.—France. Germany. Austria. Poland. Hungary. Italy. Norway. Sweden. Bornholm. Finland. N. Russia (var.). Iceland. Greenland. Nova Zembla. Siberia. India. United States. Brazil (form). Ecuador. Argentina.

C. Turpinii is a very characteristic species with a wide distribution in the British Islands. It is not a bog-species, but occurs chiefly at the weedy margins and in the plankton of large pools and shallow lakes. It thrives amongst *Potamogetons*, etc., in the surface waters of the large dykes and

drains of the east of England. It is readily distinguished by the form of the cell alone, but the granulation, and especially the binate central tumours, are also characteristic features.

Lundell was the first to discover the binate central tumours, which Brébisson had described as single. This led to the naming of the form figured by Lundell from Sweden as "var. *Lundellii* Gutw." It was very soon found that the common European form invariably possessed binate tumours, and an examination by Nordstedt of Brébisson's original specimens proved them to be identical in all respects with Lundell's Swedish form. Brébisson's description and figure of *C. Turpinii* are thus very inaccurate, and Gutwinski's "var. *Lundellii*" is nothing more than the typical plant.

As previously stated in vol. ii, p. 68, Borge has suggested that *Euastrum occidentale* W. & G. S. West is very probably a form of *C. Turpinii*. This we do not admit, and compared with the latter, the former is an exceedingly rare Desmid. A careful comparison should be made between fig. 20, Pl. XXXIX and fig. 16, Pl. LXXXII. The semicells are unlike in form, and both the granulation and the central tumours are of a different character.

Var. **podolicum** Gutw. (Pl. LXXXIII, fig. 2.)

C. Turpinii var. *podolicum* Gutw. Wahr. d. Priorität, 1890, p. 71; Flor. Glon. Okolic Lwowa, p. 62, t. 3, f. 2; Johnson, Rare Desm. U. S. II, p. 294, t. 240, f. 18; Schmidle, Beitr. Algenfl. des Schwarzwald. u. Oberrheins VI, 1897, p. 23, t. 2, f. 10–11 [figures very poor].

Cells very variable in size, sometimes rather wider than in the type; semicells with 2–3 emarginate (or bigranulate) crenations at each side just below the apex, with a row of 6 or 7 granules just above the isthmus, apex retuse with either a smooth or granulate margin; granules on various parts of the cell-wall often geminate.

Zygospore globose, covered with large mamillate warts, each of which is terminated by a short, stout, truncate spine.

Length 46–84 μ; breadth 40–83 μ; breadth of isthmus 12–21 μ; thickness 26–43 μ; diam. zygosp. without spines 54 μ, with spines 68 μ.

Ireland.—Plankton of Lough Neagh and Lough Beg!

Geogr. Distribution.—Germany. Galicia in Austria. United States.

We have regarded the var. *podolicum* as constituted by those forms of *C. Turpinii* which possess a few emarginate crenations on each side just below the apex of the semicell, and a series of large granules on each side of the isthmus. The granulation of the apex appears to be very variable, and the granules in various parts of the cell are often geminate. The binate central tumour is exactly typical. The smallest forms are those recorded by Johnson from the United States. Schmidle observed the zygospore at Heidelberg.

Var. **eximium** *var. nov.* (Pl. LXXXIII, fig. 3.)

A rather small variety with more decidedly projecting apices; semicells with a crenate margin just under the apices, with a single central tumour, the granules of which are arranged in two concentric series around three central ones, and with a single large granule on each side of the isthmus.

Length 62 μ; breadth 54 μ; breadth of isthmus 17 μ; thickness 31 μ.

Ireland.—Near Westport, Mayo!

This variety is nearest to *C. Turpinii* var. *duplo-minus* Schmidle ('Lappmark Süsswasseralgen,' 1898, p. 39, t. 2, f. 4), but is larger, with differently crenated lateral margins, a smaller apex, more numerous granules, and a more granulated central tumour. It agrees with var. *duplo-minus* in the possession of the large granule on each side of the isthmus.

179. **Cosmarium didymoprotupsum** *sp. nov.* (Pl. LXXXVIII, fig. 8.)

Cells of medium size, a little longer than broad, very deeply constricted, sinus narrowly linear with a dilated extremity; semicells broadly truncate-pyramidate, basal angles broadly rounded and granulate, sides convex, in the upper part with about 4 emarginate crenations, upper angles scarcely rounded, apex truncate and straight, 5–6-granulate; cell-wall within the

margin densely granulate, granules near the margin often in pairs, granules towards the centre of the semicells reduced, with two adjacent granulate protuberances in the centre. Side view of semicell broadly ovate-elliptic, slightly tumid at the base on each side. Vertical view elliptic, with a pair of adjacent granulate tumours at the middle on either side, poles densely granulate with the granules arranged in interrupted transverse and longitudinal series. Chloroplasts axile, with two pyrenoids.

Zygospore unknown.

Length 68 μ; breadth 59 μ; breadth of isthmus 18 μ; thickness 38 μ.

Ireland.—Near Westport, Mayo!

This species occurred sparingly amongst *C. Turpinii* var. *eximium* in a small pool near Westport. The form of the semicells and the general granulation distinguish it at once from *C. Turpinii*, the only other allied species with binate central protuberances.

180. **Cosmarium entochondrum** *sp. nov.*

(Pl. LXXXVII, fig. 17.)

Cells somewhat small, a little longer than broad, very deeply constricted, sinus narrowly linear with a slightly dilated extremity; semicells widely truncate-pyramidate (or truncate-subsemicircular), basal angles subrectangular but obtuse, furnished with a prominent conical granule, sides convex and biundulate, apical angles rounded and furnished with a single large granule, apex broadly truncate, very slightly convex, and smooth, immediately within the apex and apical angles with an arc-like series of 6 granules, the largest in the centre and smaller ones at the ends, with one large granule immediately above the isthmus, and with several (3–5) minute granules in the centre. Side view of semicell circular, with a large granule on each side near the isthmus and one on each side of the apex. Vertical view elliptic, ratio of axes about 1 : 1·7, poles

very slightly pointed and furnished with a terminal granule, and with a series of 6 granules just within each lateral margin.

Zygospore unknown.

Length 39·5 μ; breadth 33 μ; breadth of isthmus 10 μ; thickness 20 μ.

Scotland.—Rhiconich, Sutherland!

C. entochondrum should be compared with *C. quinarium* Lund., *C. taxichondrum* Lund., and *C. Paulense* (Börg.) Johns. It is nearest to the last-named species in the possession of the series of large granules within the apical margin, but the rest of the granulation differs considerably.

181. **Cosmarium Oligogongrus** Reinsch.

(Pl. XCI, fig. 8.)

Cosmarium Oligogongrus Reinsch, Contrib. Alg. et Fung. 1875, p. 84, t. 16, f. 6; De Toni, Syll. Alg. 1889, p. 1041; Roy & Biss. Scott. Desm. 1894, p. 170.
Ursinella Oligogongrus Kuntze, Revis. gen. plant. 1891, p. 925.

Cells rather under medium size, about $1\frac{1}{5}$ times as long as broad, very deeply constricted, sinus narrowly linear with a dilated extremity; semicells transversely oblong-trapeziform, apex rather narrower than the broad base, basal and upper angles obtuse, sides slightly convex and furnished with 4 or 5 equidistant marginal granules, the upper one often being apical in position, apex very broadly truncate and very slightly convex, with 7–9 granules of unequal size within each lateral margin, and with 18–19 granules of variable size irregularly disposed in the centre and surrounded by a considerable smooth area. Side view of semicell circular, with 10–11 unequal marginal granules, apex smooth or nearly so. Vertical view elliptic, ratio of axes about 1 : 1·4, unevenly granulate at the poles and at the middle on each side.

Zygospore unknown.

Length 65 μ; breadth 54–55 μ; breadth of isthmus 16 μ; thickness 38 μ.

Scotland.—Glen Dye, Kincardine (*Roy & Bissett*).
Geogr. Distribution.—Germany.

We have never observed a *Cosmarium* which we could satisfactorily identify with *C. Oligogomgrus* Reinsch. This species appears to us to belong to the same category as *C. Ungerianum* Näg., and should possibly be united with it; but until these two plants have been examined in detail, it is perhaps best to deal with them separately.

182. **Cosmarium Ungerianum** (Näg.) De Bary.

(Pl. XCI, fig. 6.)

Euastrum (*Cosmarium*) *Ungerianum* Näg. Gatt. einz. Alg. 1849, p. 120, t. 7 A, f. 10.
Cosmarium Ungerianum (Näg.) De Bary, Conj. 1858, p. 72; Arch. in Pritch. Infus. 1861, p. 732; Rabenh. Flor. Europ. Alg. III, 1868, p. 160; Nordst. Bornh. Desm. 1888, p. 195; De Toni, Syll. Alg. 1889, p. 985.
Ursinella Ungeriana Kuntze, Rev. gen. plant, 1891, p. 926.

Cells rather under medium size, about $1\frac{1}{6}$ times as long as broad, deeply constricted, sinus linear; semicells subtrapeziform-pyramidate, basal angles obtuse, lower parts of sides strongly convex, upper parts rapidly converging and almost straight, apical angles scarcely rounded, apex almost straight; cell-wall granulate, granules of unequal size, with 4 large ones on the upper lateral margins and 2 just within, with 3 smaller ones on the lower lateral margins and 2–3 just within the basal angle, with a transverse row of 4 large granules across the base just above the isthmus, and one large one within the middle of the apex; also with a number of smaller variably disposed granules in the centre of the semicells. Side view of semicell subcircular. Vertical view elliptic or elliptic-oblong, at each pole with 4 large granules and one median small one. Chloroplasts axile, with two pyrenoids.

Zygospore unknown.

Length 62 μ; breadth 54 μ; breadth of isthmus 16 μ; thickness 32 μ.

Geogr. Distribution.—Germany. Sweden. Bornholm.

C. Ungerianum has been recorded by Bennett from Hindhead, Surrey (*vide* Bennett, 'Freshw. Alg. S.W. Surrey,' 1892, p. 10, t. 2, f. 12–13), but his figures appear to be merely caricatures of *C. margaritiferum*. We have ourselves never seen any *Cosmarium* strictly comparable with *C. Ungerianum*, but from the South of England we have collected a most interesting variety of it.

Var. **subtriplicatum** West & G. S. West. (Pl. XCI, fig. 7.)

C. Ungerianum (Näg.) De Bary var. *subtriplicatum* West & G. S. West, Alg. S. England, 1897, p. 490.

A variety with oblong-rectangular semicells, superior angles rounded.

Length 67 μ; breadth 54 μ; breadth of isthmus 22 μ; thickness 36 μ.

England.—Near Chapel Wood, S.W. Surrey!

This variety occurred in fair abundance attached to the submerged stems of *Scirpus lacustris* in a large mill-pond. In its granulation it stands alone among British Desmids. It is of the same dimensions as the typical form, and has the same arrangement of granules, but the outward form of the semicells is very different. At first we considered it might be a large variety of *C. triplicatum* Wolle (consult W. & G. S. West, 'Some Desm. U. S.' 1898, p. 309 and text-fig. 5), but careful comparison with specimens of that species shows that although the external form is the same, yet the English plant is of larger size, and the arrangement of the granules is very like that in *C. Ungerianum*.

183. **Cosmarium præmorsum** Bréb. (Pl. LXXXIV, figs. 1–5.)

Cosmarium præmorsum Bréb. Liste Desm. 1856, p. 128, t. 1, f. 8 [figure poor]; Arch. in Pritch. Infus. 1861, p. 733; Rabenh. Flor. Europ. Alg. III, 1868, p. 160; Nordst. Norges Desm. 1873, p. 12, t. 1, f. 1; Cooke, Brit. Desm. 1887, p. 107, t. 42, f. 2; De Toni, Syll. Alg. 1889, p. 1000; West, Alg. N. Wales, 1890, p. 289; Alg. W. Ireland, 1892, p. 155; Alg. Engl. Lake Distr. 1892, p. 728; Schmidle, Beitr. Algenfl. Schwarzwald. u. Rheineb. 1893, p. 101; Roy & Biss. Scott. Desm. 1894, p. 171; Schmidle, Beitr. alp. Alg. 1895, p. 454, t. 15, f. 22–25 (forms); Nordst. Index Desm. 1896, p. 205; West & G. S. West, Alg. S. England, 1897, p. 490; G. S. West, Alga-fl. Cambr. 1899, p. 218; West & G. S. West, Alga-fl. Yorks. 1900, p. 75; Börg. Freshw. Alg. Færoës, 1901, p. 225; West & G. S. West, Alg. N. Ireland, 1902, p. 39; G. S. West, Treatise Brit. Freshw. Alg. 1904, p. 167, f. 62 H; West & G. S. West, Freshw.

Alg. Orkneys and Shetlands, 1905, p. 20; Borge, Beiträge Alg. Schweden, 1906, p. 31.
C. præmorsum a. *gallicum* Racib. Desm. Nowe, 1889, p. 89.
C. præmorsum b. *scandinavicum* Racib. l. c. p. 89.
Ursinella præmorsa Kuntze, Revis. gen. plant. 1891, p. 925.

Cells rather under medium size, slightly longer than broad, very deeply constricted, sinus narrowly linear with a slightly dilated extremity; semicells widely pyramidate-truncate or truncate-subsemicircular, basal angles broadly rounded, sides convex, apex widely truncate or subtruncate, often very slightly convex; apical angles rounded; cell-wall somewhat unevenly granulate, each lateral margin with about 8 granules, those nearest the apex being as a rule decidedly larger than those at the basal angles, apex smooth, with a number of irregularly scattered granules of somewhat variable size within both lateral margins and apex, in the centre of the semicells with a very variable number of large granules irregularly disposed, and sometimes intermingled with a few smaller granules, or occasionally with minute intergranular scrobiculations, generally with a fairly clear area on each side of the isthmus. Side view of semicell subcircular or widely obovate-circular. Vertical view elliptic, ratio of axes about 1 : 1·7, with the granules at the middle on each side rather more prominent than the others. Chloroplasts axile, with two pyrenoids.

Zygospore (immature?) ellipsoid, with a few scattered mamillate elevations, each terminated by a short blunt spine.

Length 47–55 μ; breadth 43–51 μ; breadth of isthmus 14–16 μ; thickness 23–29 μ; length of zygospore with spines 63 μ, breadth 52 μ.

England.—Cumberland! Westmoreland! (*Bissett*). Lancashire! W., N., and E. Yorks! Cambridgeshire! Warwickshire! Gloucestershire! Middlesex! Surrey! Kent (zygospore from Keston Common)! Hants! (*Bennett*). Devon! Cornwall!

Wales.—Llanrhwchwyn near Llanwrst, near Llanberis, Snowdon, Capel Curig, Moel Siabod, Llyn

Ogwen, and Llyn Idwal, Carnarvonshire! Llyn Coron, Anglesey!

Scotland.—Near Tillypronie, Aberdeen (*Roy & Bissett*). Glen Shee, Perth! Ben Laoigh, Argyll! Renfrew! Sutherland! Caithness! Skye in Inverness! Lewis, Harris, and N. Uist, Outer Hebrides! Orkneys! Shetlands!

Ireland.—Donegal! Near Westport, Mayo! Galway! Kerry! Louth! Armagh! Down (at 2000 ft.)! Wicklow! and Dublin (*Archer*). Lough Neagh!

Geogr. Distribution.—France. Germany. Switzerland. Austria. Norway. Sweden. Faeroes. Finland. Russia. E. Africa.

C. præmorsum is widely distributed in the British Islands, more especially in marshes, and at the weedy margins of large ponds and lakes. It sometimes occurs in bogs, but is only rarely met with among *Sphagnum*.

Owing to the imperfect nature of Brébisson's original description and figure of this species much confusion exists as to its exact identity. The Desmid which we have always identified with *C. præmorsum* Bréb. is a close ally of *C. margaritiferum*, but differs markedly in the character of its granulation. The apex is either perfectly smooth or with but few reduced granules, and the marginal granules of each side are very prominent. The granulation is entirely without any definite arrangement and is generally most irregular. The granules vary much in size, but there are always some large ones in the centre of the semicells, sometimes forming a more or less isolated group. *C. præmorsum* differs from *C. margaritiferum* in the more rounded basal angles of the semicells, in the much greater irregularity of the granulation, and in the great variability in size of the granules. There are also fewer granules on the whole cell, and generally there is a smooth area of variable extent on either side of the isthmus. There are certain forms which appear to be somewhat intermediate in character between these two species, and it is sometimes a matter of considerable difficulty to correctly place them. The species have different habitats, and it would appear from the immature zygospore of *C. præmorsum* observed from among *Scirpus fluitans* on Keston Common, Kent, that the zygospores of these two species are markedly different.

184. **Cosmarium margaritiferum** Menegh. (Pl. LXXXIII, figs. 4–11.)

? *Ursinella margaritifera* Turpin in Dict. sci. nat. planch. bot. vég. acotyl. Paris, 1820, f. 23 [figures unrecognizable]; Aperçu organograph. 1828, p. 316, t. 13, f. 19 [*Quid ?*]; Kuntze, Revis. gen. plant. 1891, p. 923.

Helierella ? margaritifera Meyen in Isis, 1830, p. 163.

Euastrum margaritiferum Ehrenb. Organisation in der Richtung des kleinsten Raumes. Berlin, 1834, pp. 246, 320; Kütz. Phyc. germ. 1845, p. 136; Focke, Phys. Stud. 1847, pp. 42, 64, t. 1, f. 6 (?), t. 2, f. 17 (?), 19 (?), 20 (?), 21 (?); Näg. Gatt. einz. Alg. 1849, p. 119.

Micrasterias margaritifera Bréb. in Mém. Soc. acad. sci. arts et bell. lettr. de Falaise, 1835, p. 55.

Cosmarium margaritiferum Menegh. Synops. Desm. 1840, p. 219; Ralfs in Ann. Mag. Nat. Hist. 1844, p. 393, t. 11, f. 4; Hass. Brit. Freshw. Alg. 1845, p. 362, t. 81, f. 1 [figure very bad]; Ralfs, Brit. Desm. 1848, p. 100, t. 16, 2 *d* [*b* and *c* ?; not 2 *a*]; Kütz. Spec. Alg. 1849, p. 176; De Bary, Conj. 1858, pp. 47, 72; Arch. in Pritch. Infus. 1861, p. 733, t. 1, f. 1; Arch. in Quart. Journ. Micr. Sci. vi, 1866, p. 274; Rabenh. Flor. Europ. Alg. 1868, III, p. 157; Nordst. Desm. Brasil. 1870, p. 207; Kirchn. Alg. Schles. 1878, p. 150; Gay, Monogr. loc. Conj. 1884, p. 64; ? Wolle, Desm. U. S. 1884, p. 74, t. 13, f. 1-3 [figures very inaccurate]; Boldt, Siber. Chlorophy. 1885, p. 107; Cooke, Brit. Desm. 1877, p. 102, t. 39, f. 2 [figures bad]; Hansg. Prodr. Algenfl. Böhm. 1888, p. 198; Boldt, Desm. Grönland, 1888, p. 26; De Toni, Syll. Alg. 1889, p. 979; West, Alg. N. Wales, 1890, p. 289; Heimerl, Desm. alp. 1891, p. 595; West, Alg. W. Ireland, 1892, p. 152; Alg. Engl. Lake Distr. 1892, p. 726; Lütkem. Desm. Attersees, 1893, p. 556; Roy. & Biss. Scott. Desm. 1894, p. 167; Nordst. Index Desm. 1896, p. 165; West & G. S. West, Alg. S. England, 1897, p. 488; Schmidle, Lappmark Süsswasseralgen, 1898, p. 33; G. S. West, Alga-fl. Cambr. 1899, p. 217; West & G. S. West, Alga-fl. Yorks. 1900, p. 71; Börg. Freshw. Alg. Færoës, 1901, p. 228; Alg. N. Ireland, 1902, p. 37; Larsen, Freshw. Alg. E. Greenland, 1904, p. 86; West & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 19; Further Contrib. Freshw. Plankton Scott. Lochs, 1905, p. 484; Comp. Study Plankton Irish Lakes, 1906, p. 85; Borge, Beiträge Alg. Schweden, 1906, p. 31.

Didymidium (*Cosmarium*) *margaritiferum* Reinsch, Algenfl. Franken, 1867, p. 118.

Cosmarium margaritiferum a. *genuinum* Kirchn. Alg. Schles. 1878, p. 151.

? *C. præmorsum* Bréb. c. *germanicum* Racib. Desm. Nowe, 1889, p. 89, t. 5, f. 39.

? ? *C. subtholiforme* Racib. var. *Malinvernianum* Racib. l. c. t. 5, f. 40 [*C. Malinvernianum* Schmidle, 1894].

C. confusum Cooke var. *regularius* (as understood by West) Alg. W. Ireland, 1892, p. 156; Alg. Engl. Lake Distr. 1892, p. 728; West & G. S. West, Some New and Int. Freshw. Alg. 1896, p. 156, t. 4, f. 41; Alg. S. England, 1897, p. 490; Alga-fl. Yorks. 1900, p. 75.

C. confusum Cooke subsp. *ambiguum* West, Alg. W. Ireland, 1892, p. 156, t. 21, f. 13 [figures imperfect]; Alg. Engl. Lake Distr. 1892, p. 728; West & G. S. West, Alg. S. England, 1897, p. 490.

C. Malinvernianum (Racib.) Schmidle var. *Badense* Schmidle, Chlorophy.-fl. Torfstiche Virnheim, 1894, p. 58, t. 7, f. 21; West & G. S. West, Alga-fl. Yorks. 1900, p. 75; Alg. N. Ireland, 1902, p. 40; Scott. Freshw. Plankton, I, 1903, p. 527.

Cells rather under medium size, slightly longer

than broad, very deeply constricted, sinus narrowly linear with a dilated extremity; semicells broadly pyramidate-truncate, basal and upper angles rounded, sides slightly convex, apex wide and straight or very slightly convex; cell-wall granulate, granules large, not quite uniform in size, those in the centre of the semicells and near the basal angles and lateral margins generally somewhat larger than the others, with 7–9 granules visible on each lateral margin, those near the apex usually smaller than those at the base, apex smooth (destitute of marginal granules), granules with no definite disposition, but scattered at equal distances, sometimes in very indistinct oblique series, with some minute scrobiculations surrounding the granules in the centre of the semicells; cell-wall between all the granules densely and very minutely punctate. Side view of semicell circular, granules of lateral margins very prominent, apex smooth. Vertical view elliptic, ratio of axes about 1 : 1·65, with the granules at the middle on each side rather larger than the other marginal granules, in the centre with a punctated area destitute of granules. Chloroplasts axile, with two pyrenoids.

Zygospore globose, wall furnished with a number of strongly convex circular thickenings (" bull's-eyes "), about 7 or 8 of which are visible at the margin.

Length 50–59 μ; breadth 42–56 μ; breadth of isthmus 13–16 μ; thickness 28–36 μ; diam. zygospore 52·5–61 μ.

England.—Cumberland! Westmoreland! (*Bissett*), at 2400 ft. on Helvellyn! Lancashire! W., N., and E. Yorks! Cheshire (with zygospores, *Roy*). Leicestershire (*Roy*). Cambridgeshire! Warwickshire! (*Wills*). Middlesex! Surrey (zygospores from Thursley Common)! Kent! Hants! (*Bennett*). Wilts! Devon! Cornwall! (*Ralfs; Marquand*). Monmouth!

Wales.—Fairly general in Carnarvonshire and Merioneth! Radnor!

Scotland. — General! Common in the Outer

Hebrides! Orkneys! Shetlands! Zygospores from south of Birsemore, Aberdeen (*Roy & Bissett*), and also from Harris, Outer Hebrides! Rare in the plankton!

Ireland.—General in Donegal!, Mayo (with zygospores)!, Galway!, and Kerry! Dublin and Wicklow (*Archer*). Down! Antrim! Lough Neagh! Somewhat rare in the plankton!

Geogr. Distribution.—France. Belgium. Germany. Switzerland. Austria. Poland. Hungary. Italy. Faeroes. Norway. Sweden. Bornholm. Denmark. Finland. Russia. Bosnia. Iceland. Greenland. Siberia. Java (form). New Zealand. Azores. United States. Mexico. Brazil.

No species of the genus *Cosmarium* has been so misinterpreted, or has given rise to greater confusion, than *C. margaritiferum*. This has been due in large part to the lack of discrimination of the earlier workers at the Desmidiaceæ, who regarded almost any granulated *Cosmarium* under a certain size as *C. margaritiferum*. Even Ralfs included three species (*viz.*:—*C. reniforme*, *C. margaritiferum*, and *C. Turnerii*) in his figures of it, and the typical form has since received at least one new name. The zygospore of true *C. margaritiferum*, which was well described by both Ralfs and Archer, is globose, and its walls are furnished with scattered thickenings which have been likened to "bull's-eyes." As the species was understood by some of the earlier observers it was undoubtedly common, and it possessed this characteristic zygospore.

Ralfs' figures of this Desmid are not good. He did not sufficiently indicate the flattened apices of the semicells, nor did he figure the intergranular punctulations and the minute scrobiculations of the central area of the semicells. His figure 2*d*, and possibly 2*b* and 2*c*, are the only ones which approximately represent the species.

In 1894 Schmidle described under the name of "*C. Malinvernianum* var. *Badense*," a *Cosmarium* which is very abundant in the bogs of the British Islands, and in other parts of Europe. It occurs principally amongst *Sphagnum*, and does not disagree with the published but incomplete descriptions of *C. margaritiferum*. Moreover, it is of the same size, and its zygospore, which we have found repeatedly, agrees exactly with that described and figured for *C. margaritiferum*. It is

inconceivable that the earlier investigators could have missed such a striking and common Desmid, seeing that they repeatedly found most of its associates ; and, moreover, amongst these associates they invariably recorded "*C. margaritiferum.*"

Hence, as we constantly find in bogs a *Cosmarium* as common as *C. margaritiferum* was reported to be, of the same size, and not differing materially from the published descriptions of that species ; and as this *Cosmarium* occurs with the same associates with which *C. margaritiferum* was generally said to be found, and as it has exactly the same zygospore, we are forced to the conclusion that IT IS *C. margaritiferum.*

At the same time this species is unquestionably identical with Schmidle's "*C. Malinvernianum* var. *Badense.*" Schmidle was the first to point out the constantly flattened apex of the semicells and the presence of the minute scrobiculations between the central granules. We have recorded this plant under the erroneous name of "*C. confusum* var. *regularius*" from many parts of the British Islands, and the Desmid described as "*C. confusum* subsp. *ambiguum*" from the west of Ireland is *C. margaritiferum* in its most typical form.

C. margaritiferum is widely distributed in the *Sphagnum*-bogs of the British Islands, especially in the western boggy areas. It is more rarely found at the boggy margins of lakes and amongst the leaves of *Littorella lacustris* and *Isoëtes lacustris.*

Special reference is also necessary to other so-called species which should merely be regarded as forms of *C. margaritiferum.* The first of these is Cooke's "*Cosmarium confusum,*" which was a name given by Cooke in 1887 to "*C. Brébissonii a genuina* Jacobs." The Desmid figured by Jacobsen only differs from *C. margaritiferum* in the spine-like adornment of the basal angles of the semicells, a character which we are inclined to think has been portrayed in an exaggerated manner. This basal 'spine' is most probably an elongated conical granule, and an approximation to this condition is often observed in specimens of *C. margaritiferum* (*vide* Pl. LXXXIII, fig. 4), in which the basal granule is larger than any of the others and of a decidedly conical shape.

Another form is that which was temporarily referred by Nordstedt to *C. confusum* as "var. *regularius.*" This appears to differ from *C. margaritiferum* only in having a granulated apex, and perhaps in its somewhat smaller dimensions.

A third form is the Desmid which has come to be known as "*Cosmarium Kirchneri* Börg." This was first described as a variety of *C. trachypleurum* Lund., but it differs from typical

C. margaritiferum only in its slightly more rounded semicells, and in the greater localization of the central scrobiculations combined with the slight differentiation of the central granules.

These three forms can be summarized as follows:—

Forma **confusa.**

Cosmarium Brébissonii Menegh. *a genuina* Jacobs. Desm. Danem. 1876, p. 194, t. 7, f. 15 (forma latior et forma angustior); Arch. in Micr. Journ. 1877, xviii, p. 305.
C. confusum Cooke, Brit. Desm. 1887, p. 110, t. 42, f. 9; De Toni, Syll. Alg. 1889, p. 995.
Ursinella confusa Kuntze, Revis. gen. plant. 1891, p. 924.

Basal angles of semicells furnished with a somewhat elongated conical granule.

Recorded from Ireland by Archer.

Forma **regularior.**

Cosmarium confusum Cooke var. *regularius* Nordst. in Bot. Notiser, 1887, p. 159; Freshw. Alg. N. Zeal. 1888, p. 47, t. 5, f. 6.

Apex of semicells furnished with a few granules; granules as a whole slightly smaller than in the type.

Length 44–53 μ; breadth 35–41 μ; breadth of isthmus 13–15 μ; thickness 26 μ. (Pl. LXXXIII, fig. 12.)

Very uncommon, but probably widely distributed.

Forma **Kirchneri.**

Cosmarium trachypleurum Lund. var. *verrucosum* Kirchn. Alg. Schles. 1878, p. 152.
C. subtholiforme Racib. var. *verrucosum* (Kirchn.) Racib. Nonn. Desm. Polon. 1885, p. 76.
C. Kirchneri Börg. Bidrag Bornh. Desm.-fl. 1889, p. 143, t. 6, f. 3; Anderss. Sverig. Chlor. 1890, p. 17; Borge, Süssw. Chlor. Archang. 1894, p. 29; Börg. Ferskv. Alg. Östgrönl. 1894, p. 12; Nordst. Index Desm. 1896, p. 151; Börg. Freshw. Alg. Færoës, 1901, p. 227.

Semicells with the apical angles more rounded, with a slight differentiation of granules in the centre and the localization of the minute scrobiculations to this small area.

Length 52–60 μ; breadth 44–52 μ; breadth of isthmus 13–18 μ; thickness 37 μ. (Pl. LXXXIII, fig. 13.)

This form has not yet been observed in the British Islands.

185. **Cosmarium quaternarium** Nordst.

(Pl. LXXXIV, figs. 6, 7.)

Cosmarium quaternarium Nordst. in Wittr. & Nordst. Alg. Exsic. 1880, no. 383; fasc. 21, p. 40; ? Cooke, Brit. Desm. 1887, p. 102, t. 42, f. 5; Nordst. Freshw. Alg. N. Zeal. 1888, p. 62, t. 7, f. 1; West, Alg. N. Wales, 1890, p. 289; West & G. S. West, Alga-fl. Yorks. 1900, p. 75.
Pleurotæniopsis quaternaria (Nordst.) De Toni, Syll. Alg. 1889, p. 914.

Cells of about medium size, a little longer than broad, very deeply constricted, sinus narrowly linear with a slightly dilated extremity; semicells broadly pyramidate-trapeziform with a subreniform base, basal angles obtusely rounded, apical angles rounded, sides slightly convex and crenate-granulate (13–14 granules along each side), apex widely truncate and smooth; cell-wall granulate, granules rather small and disposed in radiating series from the margin towards the centre, in which there is a large subcircular-elliptic area traversed by longitudinal and transverse granulate ridges between which are conspicuous scrobiculations (6 transverse and 9 longitudinal series of scrobiculations). Side view of semicell circular. Vertical view elliptic, margins granulate, granules most pronounced at the middle on each side, granules within the margin radiating from a smooth central area. Chloroplasts consisting of 4 parietal plates in each semicell, each with a single pyrenoid.

Zygospore unknown.

Length 68–72 μ; breadth 58–65 μ; breadth of apex about 26 μ; breadth of isthmus 20–24 μ; thickness 38–40 μ.

England. — Cocket Moss near Giggleswick, and Baildon Moor, W. Yorks! Cronkley Fell, N. Yorks!

Wales.—Llyn Padarn, Carnarvonshire!

Scotland.—Achmacheen, Ross!

Geogr. Distribution.—Italy. New Zealand (var.). Brazil.

C. quaternarium is larger than *C. margaritiferum*, with a much finer granulation and a different central area. Its parietal chloroplasts are also peculiar.

186. **Cosmarium Arnellii** Boldt.

(Pl. LXXXIV, fig. 11.)

Cosmarium Arnellii Boldt, Siber. Chlorophy. 1885, p. 107, t. 5, f. 15; De Toni, Syll. Alg. 1889, p. 994; Nordst. Index Desm. 1896, p. 52.
Ursinella Arnellii Kuntze, Revis. gen. plant. 1891, p. 924.

Cells rather under medium size, about $1\frac{1}{4}$ times as long as broad, deeply constricted, sinus narrowly linear; semicells trapeziform-semicircular, basal angles rectangular and very slightly obtuse, lower parts of sides perpendicular, upper parts rapidly converging towards the widely truncate apex; cell-wall finely granulate, granules in oblique series or more or less irregular, with three transverse series of larger granules across the central part of the semicells. Side view of semicell circular. Vertical view elliptic with slightly pointed poles, granules in transverse series.

Zygospore unknown.

Length 62 μ; breadth 50 μ; breadth of isthmus 21 μ; thickness 24 μ.

Geogr. Distribution. — Galicia in Austria (var.). Siberia.

C. Arnellii is somewhat related to *C. punctulatum*, but differs in its much larger size, in the shape of its semicells, in the three prominent series of granules across the centre of the semicells, and in the more attenuated poles of the vertical view. The typical form is not known to occur in the British Islands.

Forma **compressa** West. (Pl. LXXXIV, fig. 12.)

C. Arnellii Boldt forma *compressa* West, Alg. W. Ireland, 1892, p. 154, t. 21, f. 10.

Cells rather smaller and relatively wider than the type, with the three transverse series of granules in the central region of the semicells somewhat more distinct and nearer the isthmus.

Length 42 μ; breadth 37 μ; breadth of isthmus 16 μ.

Ireland.—Small lakes between Clifden and Roundstone, Galway!

187. **Cosmarium furcatospermum** West & G. S. West.

(Pl. LXXXI, figs. 10, 11; Pl. LXXXIV, figs. 8–10.)

Cosmarium furcatospermum West & G. S. West, New Brit. Freshw. Algæ, 1894, p. 7, t. 1, f. 13; Nordst. Index Desm. 1896, p. 126.

Cells small, a little longer than broad, deeply constricted, sinus linear; semicells truncate-semicircular or oblong-subsemicircular, basal angles subrectangular or slightly rounded, lateral margins 4–5-crenate-granulate, apex widely truncate and 5–6-undulate, with two (rarely with one) series of small granules within the whole margin, and with the central region of the semicells smooth or most minutely punctate. Side view of semicell subcircular. Vertical view elliptic or oblong-elliptic, ratio of axes about 1 : 1·7, sides smooth, poles undulate-granulate. Chloroplasts axile, one in each semicell, with a central pyrenoid.

Zygospore angular-globose, ornamented with short slender spines (7 visible around the periphery) very deeply bi- or trifurcate at the extremity.

Length 18–22 μ; breadth 16·5–19 μ; breadth of isthmus 5·7–7 μ; thickness 9–11 μ; diam. zygosp. without spines 23–25 μ, with spines 40–42 μ.

Scotland.—Orkneys!

Ireland.—Shores of Lough Neagh!

This species is nearest to *C. sphalerostichum* Nordst., but can be distinguished by the subundulate apices, the smooth central area of the semicells, the narrower vertical view, and the spiny zygospore. Moreover, the granules are rounded and somewhat flattened, whereas the marginal granules of *C. sphalerostichum* are acute.

188. **Cosmarium punctulatum** Bréb.

(Pl. LXXXIV, figs. 13, 14; Pl. CII, fig. 22.)

Cosmarium punctulatum Bréb. Liste Desm. 1856, p. 129, t. 1, f. 16; Rabenh. Flor. Europ. Algar. III, 1868, p. 157; Lund. Desm. Suec. 1871, p. 30; Wittr. Gotl. Öl. sötv. Alg. 1872, p. 57; Nordst. Norges Desm. 1873, p. 14; Kirchn. Alg. Schles. 1878, p. 148; ? Wolle, Desm. U. S. 1884, p. 74, t. 13, f. 4; ? Cooke, Brit. Desm. 1887, p. 104, t. 42, f. 7;

Hansg. Prodr. Algenfl. Böhm. 1888, pp. 199, 279; Boldt, Desm. Grönland, 1888, p. 27, t. 2, f. 33; Gutw. Flor. glonów Galic. 1890, p. 14; West, Alg. N. Wales, 1890, p. 289; Alg. W. Ireland, 1892, p. 153; Alg. Engl. Lake Distr. 1892, p. 727; Roy & Biss. Scott. Desm. 1894, p. 172; Börg. Ferskv. Alg. Östgrönl. 1894, p. 11; Nordst. Index Desm. p. 212; West & G. S. West, Welw. Afric. Freshw. Alg. 1897, p. 121; Alg. S. England, 1897, p. 488; Schmidle, Lappmark Süsswasseralgen, 1898, p. 126; G. S. West, Alga-fl. Cambs. 1899, p. 217; Lütkem. Desm. Central China, 1900, p. 119; West & G. S. West, Alga-fl. Yorks. 1900, p. 76; Börg. Freshw. Alg. Færoës, 1901, p. 226; Borge, Süsswasseralgen Süd-Patagon. 1901, p. 21; Bohlin, Flor. Algol. d'eau douce d. Açores, 1901, p. 66; West & G. S. West, Alg. N. Ireland, 1902, p. 38; Borge, Alg. erst. Regnell. Exped., II, Desmid. 1903, p. 88; Larsen, Freshw. Alg. E. Greenland, 1904, p. 88; W. & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 20; Further Contrib. Freshw. Plankton Scott. Lochs, 1905, p. 484; Comp. Study Plankton Irish Lakes, 1906, p. 85; Borge, Beiträge Alg. Schweden, 1906, p. 32.

C. punctulatum a. *typicum* Klebs, Desm. Ostpreuss. 1879, p. 37, t. 3, f. 50–51 [figures not accurate].

Ursinella punctulata Kuntze, Revis. gen. plant. 1891, p. 925.

Cosmarium polonicum Racib. forma Gutw. Flor. Glon. Okolic Tarnapola, 1894, p. 96, t. 3, f. 31.

Cells small, a little longer than broad, very deeply constricted, sinus narrowly linear with a slightly dilated extremity; semicells oblong-trapeziform, basal angles rounded, sides convex and slightly converging upwards, apical angles rounded, apex broadly truncate, straight or slightly convex; cell-wall granulate, granules small and of a uniform size (23 or 24 visible at the margin), generally disposed in somewhat indefinite vertical and oblique series, in the central area sometimes wanting or reduced, the smooth area (when present) always being indefinite and variable. Side view of semicell circular. Vertical view elliptic, sometimes with the slightest trace of an inflation at the middle on each side, ratio of axes about 1 : 1·8. Chloroplasts axile, with one central pyrenoid.

Zygospore globose, furnished with a number of fairly long, stout spines (about 11 visible at the margin), each arising from a broadly conical base and bifurcate or doubly bifurcate at the apex.

Length 34–36·5 μ; breadth 31–34 μ; breadth of isthmus 8·5–11 μ; thickness 17–18·5 μ; diam. zygosp. without spines 42–45 μ; with spines 65–68 μ.

England.—Cumberland! Westmoreland! (*Bissett*). Lancashire (*Roy*). W., N., and E. Yorks! Cheshire

(*Roy*). Leicestershire (*Roy*). Lincolnshire! Norfolk! Middlesex! Kent! Surrey! Devon! Cornwall! (*Marquand*).

Wales.—General in Carnarvonshire and Merioneth!

Scotland.—Rhiconich, Sutherland! Ross! Near Dinnet, and pool W. side of Loch Dawin, Aberdeen; Glen Gany, Perth; near St. Andrews, Fife (*Roy & Bissett*). Lewis and Harris, Outer Hebrides! Orkneys! Shetlands!

Ireland.—Donegal! Mayo! Galway! Kerry! Tyrone! Wicklow! (*Archer*). Armagh! Down! Londonderry! In the lake-plankton of Galway!

Geogr. Distribution.—France. Germany. Galicia in Austria. Hungary. Italy. Spain (form). Norway. Sweden. Denmark. Bornholm. Finland. Poland. Russian Lapland. Central and S. Russia. Faeroes. Iceland. Nova Zembla. Spitzbergen. Greenland. Siberia. Mongolia. Central China. Japan. Afghanistan. India. Ceylon. Singapore. Celebes. New Zealand. Madagascar (var.). E. and Central Africa. Azores. United States. Brazil. Paraguay. Patagonia.

C. punctulatum has a wide distribution in the British Islands, occurring most abundantly in peaty pools and ditches, especially among submerged *Sphagnum*. The semicells have a characteristic trapeziform shape, with rounded angles. The granulation is fine, and the granules are of a uniform size, and near the centre of the semicells there is very frequently a clear space of indefinite extent, around which the granules are often much reduced. The apex of the semicell is granulate although the granules may be somewhat reduced. Thus, even the most typical specimens of *C. punctulatum* commonly show a slight differentiation in the granulation, due mostly to the indefinite clear area in the centre of the semicells causing a separation of certain granules above the isthmus from the remainder of the cell-granules.

Other forms of *C. punctulatum* in which there is a much clearer differentiation in the granulation are quite frequent. These forms possess certain strongly developed central granules, larger than the others, and generally surrounded by a clear space. The number of central granules is very

variable, as is likewise their disposition. The apex in these forms is usually smooth, but sometimes it is quite as granulate as in typical *C. punctulatum*.

The forms with the differentiated central granules and the smooth apex have mostly been relegated to *C. subpunctulatum* Nordst., but a wide experience of all these forms has convinced us that it is not advisable to completely separate *C. subpunctulatum* from *C. punctulatum*. Many intermediate states occur, and some of them are of such a nature that it would be exceedingly difficult to decide with any degree of certainty whether they should be regarded as *C. punctulatum* or *C. subpunctulatum*. Under these circumstances we have considered *C. punctulatum* more in the light of a "species-group," with *C. subpunctulatum* as one of its extreme forms. The forms embraced in this "species-group" are *C. punctulatum* and several described varieties, *C. polonicum* Racib. and described varieties, *C. granuloculum* Roy & Biss., and *C. subpunctulatum* Nordst. Others are also closely related, such as *C. anisochondrum* Nordst. and *C. bipunctatum* Börg., and it is possible that when more is known concerning these species they also will have to be placed in the same species-group.

Nordstedt has mentioned the occurrence of a trigonal form of *C. punctulatum* (consult Nordst. 'Norges Desm.' 1873, p. 14). The smallest forms are from West Africa:—length 18 μ; breadth 18 μ; breadth of isthmus 6 μ; thickness 9 μ (consult W. & G. S. West, 'Welw. Afric. Freshw. Alg.' 1897, p. 121).

Var. **subpunctulatum** (Nordst.) Börg.

Cosmarium subpunctulatum Nordst. in Botan. Notis. 1887, p. 161; Freshw. Alg. N. Zeal. 1888, p. 47, t. 5, f. 8; De Toni, Syll. Alg. 1889, p. 1049; Borge, Bidr. Siber. Chlor. 1891, p. 11; West, Alg. W. Ireland, 1892, p. 154; Roy & Biss. Scott. Desm. 1894, p. 175; Nordst. Index Desm. 1896, p. 246; West & G. S. West, Alg. S. England, 1897, p. 488; Alga-fl. Yorks. 1900, p. 76; Notes Alg. II, 1900, p. 293, t. 412, f. 9; Alg. N. Ireland, 1902, p. 38; Freshw. Alg. Orkneys and Shetlands, 1905, p. 20.
C. punctulatum Bréb. var. *subpunctulatum* (Nordst.) Börg. Ferskv. Alg. Östgrönl. 1894, p. 11; Borge, Süsswasseralgen Süd-Patagon. 1901, p. 21 [forma *major*].

Semicells with well marked central granules often situated on a very slight central inflation; disposition of central granules very variable, but commonly in a somewhat irregular ring of 6–8 surrounding a central one.

Zygospore with shorter 2–3-furcate spines, and with a ring of 5–6 prominent teeth around the base of each spine.

Forma *α*.

C. subpunctulatum Nordst. l. c.

Apex of semicells smooth.

Length 29–34 *μ*; breadth 26–32 *μ*; breadth of isthmus 8–12 *μ*; thickness 17–18·5 *μ*; diam. zygosp. without spines about 30 *μ*, with spines 49 *μ*. (Pl. LXXXIV, figs. 15–20.)

Forma *β*.

C. subpunctulatum forma Börg. Bornholm. Desm.-fl. 1889, p. 144, t. 6, f. 4; Anderss. Sverig. Chlorophy. 1890, p. 15; Börg. Freshw. Alg. Færoës, 1901, p. 226. *C. subpunctulatum* var. *Börgesenii* West, Alg. W. Ireland, 1892, p. 154; Alg. Engl. Lake Distr. 1892, p. 727; Schmidle, Variabil. Cosmar. 1893, p. 109; West & G. S. West, Alg. S. England, 1897, p. 488; Alga-fl. Yorks. 1900, p. 76. *C. subpunctulatum* forma *Bornholmense* Lütkem. Desm. Attersees, 1893, p. 555. *C. trachypleurum* var. *minus* Racib., forma Borge, Süsswasser. Chlor. Archang. 1894, p. 28, t. 2, f. 30. *C. Karlinskii* Gutw. Nagj. dosel. Bosni Hercegovin. halugam. 1896, p. 375, t. 1, f. 6.

Apex of semicells more or less distinctly granulate.

Length 29–33 *μ*; breadth 26–30 *μ*; breadth of isthmus 9–11 *μ*; thickness 19–21 *μ*. (Pl. LXXXV, figs. 1–3.)

The two forms *α* and *β* are connected by various intermediate states, and in the following localities and distribution they are not discriminated.

England.—Langdale, Westmoreland! Hawkshead and bogs about Cockley Beck, Lancashire! Cullingworth, W. Yorks! E. Yorks! Strensall, N. Yorks! Frensham Little Pond, near Chapel Wood, and Thursley Common (with zygospores), Surrey! Hants! (*Roy*). Cornwall!

Wales.—Rhyddu, Llyn Gwynant, and Capel Curig, Carnarvonshire! Radnor!

Scotland.—Glen Garry (*Roy & Bissett*), and Craig-an-Lochan, Perth! Wigtownshire (*Roy & Bissett*). Lewis and Harris, Outer Hebrides! Orkneys! Shetlands!

Ireland.—Dungloe, near Glentornan, and Lough Machugh, Donegal! Near Westport, Mayo! Lakes between Clifden and Roundstone, and Ballynahinch, Galway! Slieve Donard, Down!

Geogr. Distribution.—Germany. Austria (form) and Silesia. Switzerland. Sweden. Bornholm. N. Russia. Bosnia. Faeroes. Siberia. New Zealand. Brazil. Patagonia (form).

The var. *subpunctulatum* differs from the type only in its more prominent and clearly differentiated central granules, which are sometimes disposed upon a very slight median inflation. The character of the apex is very variable, and all states exist from a smooth truncate apex to one which is granulate and slightly convex. It would appear that the zygospore is also somewhat different, that of the var. *subpunctulatum* being furnished with a circlet of teeth around the base of each spine (*vide* Pl. LXXXIV, fig. 20). This type of zygospore has also been described by Nordstedt for a Brazilian form—*C. punctulatum* subsp. *brasiliense* Nordst. (*vide* Wittr. & Nordst. 'Alg. Exsic.' 1882, no. 471; fasc. 21, 1889, p. 41)—which differs from typical *C. punctulatum* in the possession of two pyrenoids in each semicell.

C. punctulatum var. *ornatum* Istvanffi ('Diag. præv. Alg. nov. Hungar.' 1887, p. 237) is most probably only a small form of *C. punctulatum* var. *subpunctulatum*.

C. subpunctulatum var. *regulare* Lütkem. ('Desm. Central China,' 1900, p. 120, t. 6, f. 16) should, on the other hand, be referred to *C. subtriordinatum* W. & G. S. West ('Welw. Afric. Freshw. Alg.' 1897, p. 122, t. 368, f. 11), a tropical species not very far removed from the *C. punctulatum* species-group.

Var. **rotundatum** Klebs. (Pl. LXXXV, fig. 12.)

C. punctulatum var. *rotundatum* Klebs, Desm. Ostpreuss. 1879, p. 37, t. 3, f. 52, 54, 56 (= β), *not* f. 60 (= α); West, Alg. N. Wales, 1890, p. 289.

? ? *C. punctulatum* var. *Klebsianum* Turn. Freshw. Alg. E. India, 1893 p. 54, t. 7, f. 36 [= *C. Klebsianum* Turn. l. c. p. 55 (note)].

Semicells somewhat inflated, not so pyramidate, apex convex; granulation even, without any differentiation.

Length 37 μ; breadth 29 μ; breadth of isthmus 10 μ.

Wales.—Snowdon, Carnarvonshire!

Geogr. Distribution.—India.

It seems probable that the form we have figured (Pl. LXXXV, fig. 12) is to be referred to two (if not more) of the

forms figured by Klebs as constituting his "var. *rotundatum*." The granulation he depicts does not seem to us to be very exact, and we are quite at a loss to imagine what his fig. 60 represents.

Var. **granulusculum** (Roy & Biss.) West & G. S. West. (Pl. LXXXV, fig. 4.)

Cosmarium granulusculum Roy & Biss. Scott. Desm. 1894, p. 102, t. 2, f. 8; Nordst. Index Desm. 1896, p. 135.

Semicells with a somewhat narrower apex; granules of a uniform size and evenly distributed over the whole surface, with no definite disposition.

Length 35 μ; breadth 31 μ; breadth of isthmus 8 μ; thickness 19 μ.

Scotland. — Howford near Inverurie, Aberdeen; Gillan near Banchory, Kincardine; Folotry, Perth (*Roy & Bissett*).

We have not seen any specimens of this variety, but it appears to stand very near some of the tropical forms of *C. punctulatum*, differing only in the rather narrower apices.

189. **Cosmarium anisochondrum** Nordst. (Pl. LXXXV, fig. 5.)

Cosmarium anisochondrum Nordst. Alg. aq. dulc. et Char. Sandvic. 1878, p. 12, t. 2, f. 7; Wille, Norges Ferskv. Alg. 1880, p. 27; ? Wolle, Desm. U. S. 1884, p. 72, t. 16, f. 43–45; De Toni, Syll. Alg. 1889, p. 1029; Roy & Biss. Scott. Desm. 1894, p. 41; Nordst. Index Desm. 1896, p. 45; West & G. S. West, Alga-fl. Yorks. 1900, p. 76.
Ursinella anisochondra Kuntze, Revis. gen. plant. 1891, p. 924.

Cells small, almost as long as broad, very deeply constricted, sinus linear with a slightly dilated extremity; semicells subsemicircular (trapeziform-semicircular), base flat, basal angles subrectangular, apex widely truncate and very slightly convex, lateral margins with 7 or 8 acute granules, apex smooth, with two irregular series of minute granules within each lateral margin and with 4 or 5 granules just within the apex, also with a granulated area in the centre of the semicells (granules mostly large and rounded, dis-

posed in 4 curved transverse series, 4 in each upper and lower series, and 3 in the median series). Side view of semicell obovate-circular, with 4 prominent granules on each lateral margin. Vertical view elliptic, with 3 large granules at the middle on each side, polar regions granulate, but destitute of granules in the centre.

Zygospore unknown.

Length 28–30 μ; breadth 25–27 μ; breadth of isthmus 5·3 μ (9·5 μ according to Nordstedt); thickness 18 μ.

England.—Gormire, N. Yorks. (*W. B. Turner*).

Scotland.—Pool near Craithes Station, Kincardine (*Roy & Bissett*).

Geogr. Distribution.—Norway. Sweden. Sandwich Islands. United States.

C. anisochondrum is closely allied to *C. punctulatum* var. *subpunctulatum*, but differs in its much deeper constriction, in the rectangular basal angles of the semicells, and in the acuteness of the general granules. The central granules are also of a different character, and occupy a greater longitudinal extent (from apex to isthmus) than do those of any known form of *C. punctulatum* var. *subpunctulatum*.

The Desmid recorded and figured by Borge ('Beiträge Alg. Schweden,' 1906, p. 32, t. 2, f. 17) under the name of "*C. anisochondrum* forma" is typical *C. Boeckii* Wille, both as regards its granulation and dimensions.

190. **Cosmarium bipunctatum** Börg.

(Pl. LXXXV, fig. 6.)

Cosmarium bipunctatum Börg. Desm. Brasil. 1890, p. 40, t. 4, f. 33; West, Alg. W. Ireland, 1892, p. 153; Nordst. Index Desm. 1896, p. 62.

Cells small, almost as long as broad, deeply constricted, sinus narrowly linear with a very slightly dilated extremity; semicells widely trapeziform, basal and apical angles obtuse, sides convex, apex widely truncate, margins undulate-crenate (with 6 crenations at the apex and 6 along each side), with two irregular series of small granules within the margin, and with

two prominent granules (transversely disposed) in the centre of the semicells. Side view of semicell circular, with a granule rather below the middle on each side. Vertical view elliptic or elliptic-oblong, with a pair of prominent granules (almost forming a slight bigranulate tumour) at the middle on each side, in the centre with an elliptical smooth area. Chloroplasts axile, with one central pyrenoid.

Zygospore unknown.

Length 20 μ; breadth 19 μ; breadth of isthmus 7 μ; thickness 11·5 μ.

Wales.—Capel Curig and Yr Orsedd, Carnarvonshire!

Ireland.—Near Westport, Mayo!

Geogr. Distribution.—Brazil.

This species appears to be distinct from *C. punctulatum* by reason of its less numerous granules and the bigranulate central area of the semicells. It is also considerably smaller.

Forma **subrectangularis** *f. nov.* (Pl. LXXXV, fig. 7.)

Semicells subrectangular, apical angles rather more rounded than the basal angles; granulation as in the type.

Length 24 μ; breadth 21 μ; breadth of isthmus 6 μ; thickness 13 μ.

Scotland.—Harris, Outer Hebrides!

The Desmid described and figured by Raciborski (in 'Spraw. Kom. Fizyj. Akad. Umiej. Krakow.' xix, 1884, p. 12 (sep.), t. 1, f. 4) as *C. polonicum* appears to be intermediate in character between *C. punctulatum* and *C. bipunctatum*, but Raciborski's "species" requires accurate investigation.

191. **Cosmarium bipapillatum** West & G. S. West. (Pl. LXXXV, fig. 8.)

Cosmarium Boeckii Wille subsp. *bipapillatum* West, Alg. W. Ireland, 1892, p. 157, t. 21, f. 14; Nordst. Index Desm. 1896, p. 63.
C. bipapillatum West & G. S. West, New Brit. Freshw. Alg. 1894, p. 7.

Cells small, a little longer than broad, deeply constricted, sinus narrowly linear; semicells pyramidate-trapeziform, basal angles rounded, apical angles obtuse, sides convex and 5-undulate, apex truncate and 4-undulate, with two series of small granules within the margin (outer series of 13 granules, inner series interrupted and only of 7 granules), with two prominent granules (vertically disposed) in the centre of the semicell just above the isthmus. Side view of semicell elliptic-subcircular, with two almost papillate granules at each side near the base. Vertical view elliptic, with a prominent granule at the middle on each side.

Zygospore unknown.

Length 34 μ; breadth 28 μ; breadth of isthmus 9 μ; thickness 17 μ.

Ireland.—Creggan Lough, Galway!

This little Desmid is distinguished from *C. bipunctatum* by the form of its semicells and by the two longitudinally placed granules just above the isthmus.

192. **Cosmarium distichum** Nordst.

(Pl. LXXXVII, fig. 18.)

Cosmarium distichum Nordst. in Botan. Notis. 1887, p. 160; Freshw. Alg. N. Zeal. 1888, p. 51, t. 5, f. 16; De Toni, Syll. Alg. 1889, p. 1051; Nordst. Index Desm. 1896, p. 111.
Ursinella disticha Kuntze, Revis. gen. plant. 1891, p. 924.

Cells small, a little longer than broad, very deeply constricted, sinus linear; semicells transversely subrectangular-elliptic, basal angles subrectangular, sides convex 6-undulate-crenate, apical angles rounded, apex widely truncate and smooth, with 7 granules in the centre (six rather distant peripheral granules surrounding one central granule). Side view of semicell subcircular, slightly flattened at the apex, sides with 4 granules, and with two converging series of granules (one starting from each of the upper marginal granules) extending downwards to just above the isthmus.

Vertical view broadly elliptic, with three granules at the middle on each side and 2 just within, also with two short, rather distant series (of 4 granules each) extending inwards from each pole; cell-wall punctate.

Zygospore unknown.

Length 38–40 μ; breadth 28–35 μ; breadth at base of semicells about 25–28 μ; breadth of apex 24 μ; breadth of isthmus 10 μ; thickness 24 μ.

England.—Near Bowness, Westmoreland!

Wales.—Capel Curig, Carnarvonshire!

Geogr. Distribution.—Galicia in Austria (var.). Australia (var.). New Zealand.

Nordstedt regards this species as perhaps nearest to *C. monomazum* Lund. and *C. cristatum* Ralfs (consult pp. 139 and 140) owing to the double series of marginal granules, but the semicells are of rather different form and the granules are absent from the flattened apex.

193. **Cosmarium quinarium** Lund.

(Pl. LXXXV, figs. 9, 10.)

Cosmarium quinarium Lund. Desm. Suec. 1871, p. 28, t. 2, f. 14; Lagerh. Bidr. Amerik. Desm.-fl. 1885, p. 236; Cooke, Brit. Desm. 1887, p. 114, t. 40, f. 7 [figure bad]; De Toni, Syll. Alg. 1889, p. 1014; West, Alg. N. Wales, 1890, p. 290; Alg. W. Ireland, 1892, p. 158; Alg. Engl. Lake Distr. 1892, p. 728; Roy & Biss. Scott. Desm. 1894, p. 173; Nordst. Index Desm. 1896, p. 219; West & G. S. West, Alg. S. England, 1897, p. 490; G. S. West, Alga-fl. Cambr. 1899, p. 218; West & G. S. West, Alga-fl. Yorks. 1900, p. 76; Alg. N. Ireland, 1902, p. 39.
Ursinella quinaria Kuntze, Revis. gen. plant. 1891, p. 925.

Cells somewhat small, subhexagonal in general outline, about $1\frac{1}{4}$ times as long as broad, deeply constricted, sinus narrowly linear with a slightly dilated extremity; semicells broadly pyramidate-truncate, basal angles obtuse, apical angles rounded, sides convex, apex truncate, margin furnished with 14–15 acute granules which give it an acutely undulate character, with a series of 10 acute or rounded granules just within the margin, and with 5 large granules in the centre disposed in two transverse series, 3 in the upper series and 2 in the lower series, with about 3 punctulations between them. Side view

of semicell circular, with three acute granules at each side. Vertical view elliptic and granulate except for a smooth area in the centre, granules at the middle on each side larger and more prominent, marginal granules acute. Chloroplasts axile, with two pyrenoids.

Zygospore unknown.

Length 39–42 μ; breadth 33–34·5 μ; breadth of isthmus 9·5–11 μ; thickness 22–23 μ.

England.—Brothers' Water and near Bowness, Westmoreland! Mickle Fell and Pilmoor, N. Yorks! Near Ely, Cambridgeshire! Near Chapel Wood, Surrey! New Forest, Hants!

Wales.—Capel Curig and Llyn-y-cwm-ffynon, Carnarvonshire!

Scotland.—Rhiconich, Sutherland! Near Dinnet, Aberdeen (*Roy & Bissett*). Lewis and Harris, Outer Hebrides!

Ireland.—Loughs Cloncarney and Darragh, Donegal! Ballynahinch, Loughs Creggan and Shannacloontippen, Galway! Kenmare and near Lough Brin, Kerry!

Geogr. Distribution.—France. Norway. Sweden. Bengal (var.). United States.

C. quinarium is a characteristic species with a wide British distribution. Its marginal granulation is of a similar nature to that of *C. Boeckii*, but the semicells are more trapezoid, and the granulation within the margin and at the centre is very different.

Forma **irregularis** Nordst.

C. quinarium Lund. forma *irregularis* Nordst. Norges Desm. 1873, p. 13; Roy. & Biss. Scott. Desm. 1894, p. 173.

Semicells with 5–9 central granules disposed in an irregular manner; other characters as in the type.

Scotland.—Loch Ruthven, Inverness (*Roy & Bissett*).

Geogr. Distribution.—Norway.

This form may possibly have as wide a distribution as the type, but we have never observed it.

194. **Cosmarium subtrinodulum** West & G. S. West.

(Pl. XCI, fig. 9.)

Cosmarium subtrinodulum West & G. S. West, Notes Alg. II, 1900, p. 292, t. 412, f. 11; Nordst. Index Desm. Suppl. 1908, p. 122.

Cells rather under medium size, a little longer than broad, very deeply constricted, sinus narrowly linear with a dilated extremity; semicells transversely pyramidate-oblong, basal angles obtuse, apical angles rounded, sides (including superior angles) with 3–4 rather distant undulations or nodulations, apex wide and slightly convex; with 3 small tumours in the centre of the semicells, subtransversely disposed, each tumour surrounded by a ring of small scrobiculations, and also with other minute scattered scrobiculations (or punctulations) round about. Vertical view elliptic, poles undulate, with a slight trinodulose inflation at the middle on each side. Cell-wall thick.

Zygospore unknown.

Length 47·5 μ; breadth 39 μ; breadth of isthmus 11·5 μ; thickness 27 μ.

England.—Near Bowness, Westmoreland!

This species stands nearest to *C. trinodulum* Nordst. ('Alg. et Char.' I, 1880, p. 5, t. 1, f. 4), but differs in the disposition of the nodules in the upper part of the margin of the semicells, in the more rounded basal angles, in the general arrangement of the central tumours (with their accompanying scrobiculations), in the inflated vertical view, and the thickened cell-wall.

195. **Cosmarium fastidiosum** West & G. S. West.

(Pl. LXXXV, fig. 11.)

Cosmarium fastidiosum West & G. S. West, Alg. S. England, 1897, p. 489, t. 6, f. 11; Nordst. Index Desm. Suppl. 1908, p. 59.

Cells small, a little longer than broad, deeply constricted, sinus narrowly linear with a slightly dilated extremity; semicells trapeziform-semicircular, basal angles rounded, sides convex and 7–8 granulate

(granules acute), apex broadly truncate (very slightly convex) and smooth, with a number of minute scattered granules within both lateral and apical margins, and with 3 or 4 larger flattened granules in the centre. Side view subcircular. Vertical view elliptic, minutely granulate except for a smooth central area, and with three large flattened granules at the middle on each side. Chloroplasts axile with a large central pyrenoid.

Zygospore unknown.

Length 37–38·5 μ; breadth 33–36 μ; breadth of isthmus 11 μ; thickness 21 μ.

England.—Near Goring, S.E. Oxfordshire!

This Desmid was frequent among other Algæ in a small pond near Goring in Oxfordshire. It should be carefully compared with *C. punctulatum* var. *subpunctulatum* and with *C. Boeckii*, from both of which it can be distinguished without difficulty.

196. **Cosmarium Kjellmani** Wille.

(Pl. LXXXV, fig. 13.)

Cosmarium Kjellmani Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 42, t. 12, f. 31; ? Wolle, Desm. U. S. 1884, p. 87, t. 49, f. 19–21; Cooke, Brit. Desm. 1887, p. 113, t. 42, f. 11; De Toni, Syll. Alg. 1889, p. 1026; West, Alg. W. Ireland, 1892, p. 158; Roy & Biss. Scott. Desm. 1894, p. 104; Nordst. Index Desm. 1896, p. 152; West & G. S. West, Alga-fl. Yorks. 1900, p. 76.

Ursinella Kjellmani Kuntze, Revis. gen. plant. 1891, p. 925.

Cells small, as long as broad, deeply constricted, sinus narrowly linear with a slightly dilated extremity; semicells widely truncate-pyramidate or trapeziform-subsemicircular, basal angles obtuse, sides convex and strongly converging upwards from a broad base to a somewhat narrow apex, apical angles not rounded, apex truncate and straight; cell-wall minutely granulate, about 6 granules showing on each lateral margin and 5 or 6 at the apical margin, granules within the margin radially arranged, with a tumour in the centre furnished with 5 vertical series of granules. Side view of semicell ovate, with a granulated tumour near

the base on each side, upper part of sides retuse, apex granulate. Vertical view narrowly elliptic, with granulate poles, and with a 5-granulate tumour at the middle on each side. Chloroplasts axile, with a central pyrenoid.

Zygospore unknown.

Length 28 μ; breadth 28 μ; breadth of isthmus 9 μ; thickness 18 μ; breadth of apex 10 μ.

England.—Near Bowness, Westmoreland (*Bissett*). Rombald's Moor and above Eldwick, W. Yorks! Near the Moorcock Inn, N. Yorks! Delamere, Cheshire (*Roy*). Leicestershire (*Roy*).

Scotland.—Dalbagie near Ballater, and Slewdrum, Aberdeen (*Roy & Bissett*).

Ireland.—Near Lough Brin, Kerry!

Geogr. Distribution.—France. Galicia in Austria (var.). Nova Zembla. Greenland. Siberia. United States (?).

This small species is in its typical form very characteristic. It should be compared with *Cosmarium subcrenatum* and *C. subcostatum* forma *minor*.

Var. **ornatum** Wille. (Pl. LXXXV, fig. 14.)

C. Kjellmani Wille var. *ornatum* Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 42, t. 12, f. 32; Borge in Botan. Notis. 1892, p. 59; West, Alg. W. Ireland, 1892, p. 158; Borge, Süssw. Chlor. Archang. 1894, p. 30; Beiträge Alg. Schweden, 1906, p. 42 [forma].

A little smaller than the type, with a slightly open sinus, lateral margins with 3–4 small bidenticulate (or emarginate) warts replacing the normal simple granules, generally with one or two simple granules at the basal angles, central tumour with 4 or 5 vertical series of small granules. Side and vertical views relatively stouter. Chloroplasts with one pyrenoid.

Length 21–26 μ; breadth 20–24 μ; breadth of isthmus 6·5–9 μ; thickness 15–16 μ.

Ireland.—Athry Lough, Galway!

Geogr. Distribution.—Sweden. N. Russia. Nova Zembla. Japan.

This variety is distinguished by the bidenticulate crenations of the lateral margins, and in this respect it closely resembles *C. subcrenatum* var. *divaricatum* Wille and *C. subcostatum* forma *minor* W. & G. S. West. It appears to be a connecting-form between *C. Kjellmani* and *C. subcrenatum*.

Var. **grande** Wille. (Pl. LXXXV, fig. 15.)

C. Kjellmani subsp. *grande* Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 43, t. 12, f. 33; Boldt, Desm. Grönland, 1888, p. 24; Borge, Siber. Chlor. 1891, p. 13; Roy & Biss. Scott. Desm. 1894, p. 104; West & G. S. West, Alg. S. England, 1897, p. 489; Alga-fl. Yorks. 1900, p. 76; Börg. Freshw. Alg. Færoës, 1901, p. 227; West & G. S. West, Scott. Freshw. Plankton, I, 1903, p. 527.

Larger than the type, with the semicells proportionately a little higher, with relatively more granules (about 8 marginal on each side); granules forming the 5 vertical series covering the central tumour more pronounced; chloroplasts with two pyrenoids.

Length 45–52 μ; breadth 40–47 μ; breadth of isthmus 13–16 μ; thickness 18–26 μ.

England.—Baildon Moor, W. Yorks! Ranmore Common, Surrey!

Scotland.—Bourtie, Aberdeen (*Roy & Bissett*). Plankton of Loch Laxadale, Harris, Outer Hebrides!

Geogr. Distribution.—Bornholm. Faeroes. Nova Zembla. Greenland. Siberia.

This variety is distinguished by its larger size, its proportionately longer cells, and the two pyrenoids in each chloroplast. We do not attach too much importance to the latter character, even though the type form of *C. Kjellmani* has only one central pyrenoid in each semicell. The larger size of the cell may possibly account for the duplication of the pyrenoids.

197. **Cosmarium humile** (Gay) Nordst.

(Pl. LXXXV, figs. 16–18.)

Euastrum (*Cosmarium*) *celatum* Gay, Monogr. loc. Conj. Montpellier, 1884, p. 59, t. 1, f. 17. [This is not *C. cælatum* Ralfs, 1848.]

Euastrum (*Cosmarium*) *humile* Gay, Note Conj. du midi de France, 1884, p. 336.

Cosmarium humile (Gay) Nordst. in De Toni, Syll. Alg. 1889, p. 965;

Schmidle, Beitr. alp. Alg. 1895, p. 389; West & G. S. West, Alga-fl. Yorks. 1900, p. 77; Alg. N. Ireland, 1902, p. 37; Scott. Freshw. Plankton, I, 1903, p. 527; Freshw. Alg. Orkneys and Shetlands, 1905, p. 20; Further Contrib. Freshw. Plankton Scottish Lochs, 1905, p. 484; Comp. Study Plankton Irish Lakes, 1906, p. 85.

Ursinella humilis Kuntze, Revis. gen. plant. 1891, p. 924.

Cells very small, slightly longer than broad, very deeply constricted, sinus narrowly linear with a very slightly dilated extremity; semicells trapeziform, broader at the base than at the apex, basal angles scarcely rounded, lower part of sides convex and 3-undulate, upper part retuse, apical angles very slightly outstanding and retuse-emarginate, apex broadly truncate and 2–4-undulate, with a few small irregularly scattered granules within the margins, sometimes grouped in twos or threes, and with a single relatively large granule in the centre. Side view of semicell subcircular with a flattened granule just below the middle on each side. Vertical view elliptic, with a flattened granule at the middle on each side. Chloroplasts axile, with a single central pyrenoid.

Zygospore unknown.

Length 13·4–15·4 μ; breadth 12·5–15 μ; breadth of isthmus 4–5 μ; thickness 8–8·5 μ.

England.—Cumberland! Westmoreland! W. and N. Yorks! Lincolnshire! Cambridgeshire! Surrey! Hants! Devon! Cornwall!

Wales.—Capel Curig, Llyn-y-cwm-ffynon, Llyn Idwal, and Glyder Fach, Carnarvonshire! Dolgelly, Merioneth!

Scotland.—Rhiconich, Sutherland! Inverness (and Skye)! Perth! Common in Lewis and Harris, Outer Hebrides! Orkneys! Shetlands!

Ireland.—Donegal! Galway! Armagh! Down! Lough Neagh! Londonderry! Plankton of the lakes of Mayo and Galway!

Geogr. Distribution.—France. Switzerland. Germany. Galicia in Austria.

C. humile is one of the most widely distributed and characteristic British species of the genus. It has a most

distinctive form, but its granulation is very variable. Scarcely two individuals can be found with precisely the same disposition of granules, and in all cases the granulation is somewhat indistinct. Much confusion has existed concerning the different forms frequently met with, and Schmidle was the first to point out the close affinity of certain so-called "species" which he afterwards grouped under *C. humile*.

We find *C. humile* mostly in large ditches, and at the weedy margins of large ponds and lakes. It occurs very rarely among submerged *Sphagnum*, but is frequent in the plankton of certain of the British lakes.

Var. **striatum** (Boldt) Schmidle. (Pl. LXXXV, figs. 21, 22.)

Cosmarium striatum Boldt, Siber. Chlorophy. 1885, p. 104, t. 5, f. 9; Desm. Grönland, 1888, p. 14; De Toni, Syll. Alg. 1889, p. 940; Anderss. Sverig. Chlor. 1890, p. 15; West, Alg. N. Wales, 1890, p. 289; Lütkem. Desm. Attersees, 1893, p. 553; Roy & Biss. Scott. Desm. 1894, p. 175; Nordst. Index Desm. 1896, p. 241; West & G. S. West, Desm. Singapore, 1897, p. 164; Hirn, Desm. Finnland, 1903, p. 13; Larsen, Freshw. Alg. E. Greenland, 1904, p. 89.

Ursinella striata Kuntze, Revis. gen. plant. 1891, p. 925.

Cosmarium humile (Gay) Nordst. var. *striatum* (Boldt) Schmidle, Beitr. alp. Alg. 1895, p. 389; West & G. S. West, Alga-fl. Yorks. 1900, p. 77; Borge, Beiträge Alg. Schweden, 1906, p. 34.

Cells without granules, apical angles of semicells not emarginate, with no granule in the centre of the semicells.

Length 12·5–16 μ; breadth 12–17 μ; breadth of isthmus 4–5 μ; thickness 6–12 μ.

England.—Pilmoor, N. Yorks! Delamere, Cheshire (*Roy*). Enbridge Lake, Hants (*Roy*). New Forest, Hants!

Wales.—Glyder Fawr, Carnarvonshire (*Roy*). Llyn Coron, Anglesey!

Scotland. — Aberdeen and Kincardine (*Roy & Bissett*).

Geogr. Distribution.—Germany. Austria. Galicia in Austria (var.). Norway. Sweden. Finland. Faeroes. Siberia. Singapore. United States. Patagonia.

This variety is distinguished by its rounded apical angles and by the complete absence of granules. The apex is undulate exactly as in the type.

Var. **substriatum** (Nordst.) Schmidle. (Pl. LXXXV, fig. 20.)

Cosmarium substriatum Nordst. in Wittr. & Nordst. Alg. Exsic. 1889, no. 977; fasc. 21, p. 42 (c. fig.); West, Alg. W. Ireland, 1892, p. 149; Alg. Engl. Lake Distr. 1892, p. 726; Roy & Biss. Scott. Desm. 1894, p. 175; Nordst. Index Desm. 1896, p. 247; West & G. S. West, Alg. S. England, 1897, p. 488; G. S. West, Alga-fl. Cambr. 1899, p. 217.

C. humile (Gay) Nordst. var. *substriatum* (Nordst.) Schmidle, Beitr. alp. Alg. 1895, p. 389; W. & G. S. West, Alga-fl. Yorks. 1900, p. 77; Alg. N. Ireland, 1902, p. 37; Freshw. Alg. Orkneys and Shetlands, 1905, p. 20; Borge, Beiträge Alg. Schweden, 1906, p. 34.

Cells commonly larger than in the type, lower parts of sides of semicells retuse, apical angles rounded, apex without undulations but with two series of granules within the margin, granules within the sides more clustered and restricted.

Length 17–28 μ; breadth 14–24 μ; breadth of isthmus 5–8 μ; thickness 11–14 μ.

England.—Cumberland! Westmoreland! W., N., and E. Yorks! Lincolnshire! Cambridgeshire! Oxfordshire! Surrey! Hants! Devon! Cornwall!

Wales.—Llyn Ogwen, Llyn Bodgynwydd, and Llyn-an-afon, Carnarvonshire!

Scotland. — Rhiconich, Sutherland! Craig-an-Lochan, Perth! Cumbrae, Ayr! Orkneys! Shetlands!

Ireland.—Donegal! Mayo! Galway! Kerry!

Geogr. Distribution.—Germany. Galicia in Austria. Sweden. Patagonia.

This variety differs from the type in the retuse lower parts of the lateral margins of the semicells, in the rounded angles, and in the different and more restricted disposition of the granules.

Var. **danicum** (Börg.) Schmidle. (Pl. LXXXV, fig. 19.)

Cosmarium danicum Börg. Bornholm. Desm.-fl. 1889, p. 145, t. 6, f. 6; Borge, Süssw. Chlor. Archang. 1894, p. 26; Roy & Biss. Scott. Desm. 1894, p. 45; Nordst. Index Desm. 1896, p. 97.

C. humile (Gay) Nordst. var. *danicum* (Börg.) Schmidle, Beitr. alp. Alg. 1895, p. 389.

Lower parts of sides of semicells retuse, apical

angles slightly rounded and not projecting; granulation not fundamentally different from that of the type.

Length 15–16 μ; breadth 14–14·5 μ; breadth of isthmus 5 μ; thickness 8·5 μ.

Scotland.—Near Alford, Aberdeenshire (*Roy & Bissett*).

Geogr. Distribution.—Germany. Denmark (Bornholm). N. Russia. Iceland.

Var. **glabrum** Gutw. (Pl. LXXXV, figs. 23, 24.)

Cosmarium humile (Gay) Nordst. var. *glabrum* Gutw. in Nuova Notarisia, 1892, p. 21; Flor. Glonow Galic. 1892, p. 132, t. 3, f. 14; Schmidle, Beitr. alp. Alg. 1895, p. 389 [" *glabratum*"]; West & G. S. West, Alg. N. Ireland, 1902, p. 37.

Outline of semicells as in the type; central granule present but the rest of the cell-wall destitute of granules.

Length 14·5–18·4 μ; breadth 13·3–16 μ; breadth of isthmus 4·2–4·6 μ; thickness 9·5–12 μ.

England. — Westmoreland! W. and N. Yorks! Surrey! Hants! Devon! Cornwall!

Scotland.—Sutherland!

Ireland.—Common in Galway and Mayo! Lough Gartan, Donegal!

Geogr. Distribution.—Galicia in Austria. Sweden.

198. **Cosmarium Blyttii** Wille. (Pl. LXXXVI, figs. 1–4.)

Cosmarium Blyttii Wille, Norges Ferskv. Alg. 1880, p. 25, t. 1, f. 7; ? Wolle, Desm. U. S. 1884, p. 87, t. 19, f. 31–33; Nordst. Desm. Grönl. 1885, p. 8, t. 7, f. 4 [forma]; Freshw. Alg. N. Zeal. 1888, p. 49; De Toni, Syll. Alg. 1889, p. 1013; West, Alg. N. Wales, 1890, p. 289; Freshw. Alg. Maine II, 1891, p. 355; Alg. W. Ireland, 1892, p. 154; Alg. Engl. Lake Distr. 1892, p. 727; Roy & Biss. Scott. Desm. 1894, p. 42; West & G. S. West, Alg. Madag. 1895, p. 64; Nordst. Index Desm. 1896, p. 63; West & G. S. West, Welw. Afric. Freshw. Alg. 1897, p. 122; Alg. S. England, 1897, p. 489; Schmidle, Ost-Afrika Desm. 1898, p. 28; West & G. S. West, Alga-fl. Yorks. 1900, p. 77; Freshw. Chlorophy Koh Chang, 1901, p. 174 [inclus. f. *minor*]; Alg. N. Ireland, 1902, p. 38; Freshw. Alg. Ceylon, 1902, p. 172; Freshw. Alg. Orkneys and Shetlands, 1905, p. 20; Further Contrib. Plankton Scott. Lochs, 1905, p. 484; Borge, Beiträge Alg. Schweden, 1906, p. 34; G. S. West, Alg. Third Tanganyika Expedit. 1907, p. 121.

Ursinella Blyttii Kuntze, Revis. gen. plant. 1891, p. 924.

Cells very small, slightly longer than broad, very deeply constricted, sinus narrowly linear; semicells trapeziform-semicircular, basal angles subrectangular, sides commonly 4-crenate (including the basal and apical angles), with the third crenation from the base usually emarginate and often with a retuse-emarginate basal crenation, apex truncate and 4-crenate (including the two upper lateral crenations), with one or two series of small granules within the marginal crenations, and with a subpapillate granule in the centre. Side view of semicell subcircular from a flattened base, with a well-marked granule at the middle on each side. Vertical view elliptic or rather narrowly elliptic, with a prominent granule at the middle on each side. Chloroplasts axile, with one central pyrenoid.

Zygospore unknown.

Length 10–19 μ; breadth 7–16 μ; breadth of isthmus 2·8–5·5 μ; thickness 8–11 μ.

England.—Harrop Tarn, Cumberland! Helvellyn, Westmoreland, at 2400 ft. (a small form)! Cockett Moss near Giggleswick, and Cragg Vale towards Blackstone Edge, W. Yorks! Mickle and Cronkley Fells, N. Yorks! Skipwith Common, E. Yorks! Bisley and Thursley Commons, Surrey! Hants (*Roy*).

Wales.—Capel Curig, Llyn Padarn, Llyn-y-cwmffynon, and Llyn-an-afon, Carnarvonshire!

Scotland.—Sutherland!, Ross, Inverness!, Aberdeen!, Kincardine, Argyll (Mull), Fife (*Roy & Bissett*). Kirkcudbright! Lewis and Harris, Outer Hebrides! Orkneys!

Ireland.—Donegal! Mayo! Galway! Kerry! Down!

Geogr. Distribution.—France. Germany. Austria. Galicia in Austria. Norway. Sweden. Bornholm. Greenland. Central China. Ceylon. Siam. Australia (form). New Zealand. Madagascar. Central and E. Africa. United States.

C. Blyttii is one of the smallest and most characteristic of the rough species of *Cosmarium*. It has a very wide distri-

bution in the British Islands, occurring mostly in bogs and at the weedy margins of lakes. It exhibits considerable variation in the crenation of the lateral margins of the semicells and in the extent of the granulation. We have not attempted to discriminate between those forms exhibiting only minor differences, as so many intermediate states exist.

Var. **Novæ-Sylvæ** West & G. S. West. (Pl. LXXXVI, figs. 5, 6.)

C. Blyttii Wille var. *Novæ-Sylvæ* West & G. S. West, Alg. S. England, 1897, p. 489, t. 6, f. 10.

Cells a little larger, often more or less oblong-subrectangular, lateral crenations more prominent and truncate, usually with only one series of granules within the margin, and with an arc of 4 small granules on the lower side of the central granule.

Length 20·5–22 μ; breadth 17·5–19 μ; breadth of isthmus 5·5 μ; thickness 10 μ.

England.—New Forest, Hants!

This variety occurred in abundance in one of the *Sphagnum*-bogs of the New Forest. It should be compared with *C. Blyttii* subsp. *Hoffii* Börg. ('Bornholm. Desm.-fl.' 1889, p. 144, t. 6, f. 5), from which it differs in being proportionately longer, in its more pronounced lateral crenations, and in the central granules of the semicells.

199. **Cosmarium sexnotatum** Gutw. (Pl. LXXXVI, fig. 7.)

Cosmarium sexnotatum Gutw. in Nuova Notarisia, 1892, p. 19; Flor. Glonow Galic. 1892, p. 125, t. 3, f. 7.

Cells small, almost $1\frac{1}{3}$ times as long as broad, deeply constricted, sinus narrowly linear; semicells subsemicircular with a flat base, basal angles subrectangular, sides convex and 4-crenate, apex subtruncate (slightly convex) and 4-crenate, with a single series of small granules within the margin, and with an interrupted inner series consisting of 3 within the apex and 3 within each lateral margin, in the centre above and rather close to the isthmus with a transverse

row of 3 vertically elongated granules. Side view of semicell subcircular. Vertical view elliptic or subrhomboid-elliptic, margins granulate, the 3 granules at the middle on each side more prominent than the others. Chloroplasts axile, with a central pyrenoid.

Zygospore unknown.

Length 25 μ; breadth 19 μ; breadth of isthmus 5 μ.

Geogr. Distribution.—Galicia in Austria.

The typical form of this species has not been observed from the British Islands.

Var. **tristriatum** (Lütkem.) Schmidle. (Pl. LXXXVI. figs. 8, 9.)

Cosmarium Blyttii Wille forma *tristriatum* Lütkem. Desm. Attersees, 1893, p. 553, t. 8, f. 5; Desm. Millstättersees, 1900, p. 66.
C. sexnotatum Gutw. var. *tristriatum* (Lütkem.) Schmidle, Beitr. alp. Alg. 1895, p. 458.

Semicells pyramidate-trapeziform, with a truncate apex, straight or slightly undulate; one or all of the 3 elongated central granules divided into two parts, generally into a larger and a smaller portion.

Length 16–26 μ; breadth 14–22 μ; breadth of isthmus 4–8 μ; thickness 9–14·5 μ.

Wales.—Glyder Fach, Carnarvonshire!

Scotland.—Rhiconich, Sutherland! Harris, Outer Hebrides!

Ireland.—Lough Gartan, Donegal! Near Oughterard, Galway!

Geogr. Distribution.—Austria. Sweden. Roumania.

This variety exhibits considerable variation in size and in the details of the central granules. Its chief distinction from typical *C. sexnotatum* is in the pyramidate form of the semicells.

200. **Cosmarium subcrenatum** Hantzsch. (Pl. LXXXVI, figs. 10–14.)

Cosmarium subcrenatum Hantzsch in Rabenh. Alg. 1861, no. 1213; Rabenh. Flor. Europ. Alg. III, 1868, p. 164; Nordst. Desm. Arctoæ, 1875, p. 21, t. 6, f. 10–11; Desm. Ital. 1876, p. 35; Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 40; ? Wolle, Desm. U. S. 1884, p. 84, t. 18, f. 6–7, t. 19, f. 20; Boldt, Siber. Chlorophy. 1885, p. 106; Hansg. Prodr. Algenfl. Böhm. 1888, p. 201; Boldt, Desm. Grönland, 1888, p. 18; Nordst. Bornh. Desm.

1888, p. 196; De Toni, Syll. Alg. 1889, p. 1000; West, Alg. N. Wales, 1890, p. 290; Borge, Bidr. Siber. Chlor. 1891, p. 11; West, Alg. W. Ireland, 1892, p. 150; Börg. Ferskv. Alg. Östgrönl. 1894, p. 14; Gutw. Flor. Glon. Okolic Tarnapola, 1894, p. 95; Roy & Biss. Scott. Desm. 1894, p. 175; Nordst. Index Desm. 1896, p. 244; West & G. S. West, Alg. S. England, 1896, p. 488; Some Desm. U. S. 1898, p. 304; Schmidle, Lappmark Süsswasseralgen, 1898, p. 36; West & G. S. West, Alga-fl. Yorks. 1900, p. 70; Börg. Freshw. Alg. Færoës, 1901, p. 227; West & G. S. West, Alg. N. Ireland, 1902, p. 37; Larsen, Freshw. Alg. E. Greenland, 1904, p. 89; West & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 18; Borge, Beiträge Algen Schweden, 1906, p. 34.

Ursinella subcrenata Kuntze, Revis. gen. plant. 1891, p. 925.

Cosmarium costatum Nordst., forma Gutw. Flor. glonów Galic. 1892, p. 130, t. 3, f. 12.

C. Boldtianum Gutw. Flor. Glon. Okolic Tarnapola, 1894, p. 100, t. 3, f. 36.

C. subreniforme Nordst. forma? Schmidle, Lappmark Süsswasseralgen, 1898, p. 41, t. 2, f. 9.

Cells small, a little longer than broad, deeply constricted, sinus narrowly linear; semicells subsemicircular with a truncate apex, basal angles more or less subrectangular, sides 4–6 (commonly 5)-crenate, upper crenations slightly larger than lower crenations, apex 4 (more rarely 5)-crenate, generally with minute binate granules immediately within each crenation (except the one or two basal ones), and within these with one or two series of minute granules disposed both radially and concentrically, with a broad flattened tumour in the centre above the isthmus furnished with 5–7 vertical series of granules (3–6 granules in each series). Side view of semicell ovate from a broad base, apex truncate, upper parts of sides retuse. Vertical view elliptic, with a broad tumour on each side furnished with about 5 very distinct granules, poles rounded or truncate. Chloroplasts axile, one in each semicell with a single central pyrenoid.

Zygospore globose, furnished with short, scattered spines, each arising from a conical base, and with an emarginate or slightly furcate apex.

Length 23–37 μ; breadth 18–30 μ; breadth of isthmus 8–14 μ; thickness 12–19 μ; diam. zygosp. without spines 32–35 μ; length of spines 8–10 μ.

England.—W. and N. Yorks! Essex! Middlesex! Surrey! Hants (*Roy*). Cornwall!

Wales. — Snowdon !, Penygwryd (*Roy*), Llyn-y-cwm-ffynon !, and Yr Orsedd !, Carnarvonshire.

Scotland. — Ross, Inverness !, Banff, Aberdeen, Kincardine, Forfar !, Perth ! (*Roy & Bissett*). Dumbarton ! Cumbræ ! Orkneys ! Shetlands ! Lewis, Outer Hebrides !

Ireland.—Donegal ! Muckross, Carrantuohill, and Cloonee Lough, Kerry ! Down (up to 2000 ft.) !

Geogr. Distribution.—France. Germany. Galicia in Austria. Italy. Spain. Norway. Sweden. Bornholm. Finland. Poland. N. Russia. Faeroes. Iceland. Nova Zembla. Franz Joseph Land. Spitzbergen. Greenland. Siberia. Manchuria. Sumatra. E. and Central Africa. United States. Ecuador. Uruguay. Patagonia.

This species has in the past been much confused with other more or less closely allied Desmids, and it has most probably a wider distribution than is indicated by its recorded localities. It is distinguished from *C. crenatum* Ralfs by its proportionately wider and less rectangular semicells, by its larger number of crenations, and by the more evident granulation, especially of the central tumour. It should also be compared with *C. subcostatum* var. *Beckii*, from which it differs in the form of its semicells, its more rounded crenations, and in the nature of the granulation of its central tumour.

Nordstedt has described and figured a trigonal variety (var. *triquetrum* Nordst.) from Spitzbergen.

We give a figure of a reduced form in which the granulation of the central tumour was largely wanting (Pl. LXXXVI, fig. 15).

Zygospores of *C. subcrenatum* were observed by L. N. Johnson from Arlington, Massachussets, U. S. A.

Var. **divaricatum** Wille. (Pl. LXXXVI, figs. 16–18.)

C. subcrenatum Hantzsch var. *divaricatum* Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 40, t. 12, f. 27; Boldt, Desm. Grönland, 1888, p. 19; Gutw. Flor. Glon. Okolic Lwowa, 1891, p. 58; West, Alg. W. Ireland, 1892, p. 150; Schmidle, Ost-Afrika Desm. 1898, p. 28.

Semicells with the lateral crenations (except the lowest smaller ones) and those at the apical angles bidenticulate or truncate-emarginate, central tumour furnished with 6–8 vertical series of granules.

Length 24–31 μ; breadth 21–26 μ; breadth of isthmus 7·5–9·5 μ; thickness 17–19·5 μ.

Ireland.—Creggan Lough, Galway!

Geogr. Distribution.—Galicia in Austria. Nova Zembla. Greenland. E. Africa.

This variety approaches very closely certain forms of *C. subcostatum*, a species with which it should be very carefully compared. It differs only in its central tumour, which is much broader and furnished with 6–8 vertical series of granules. There is only one pyrenoid in each chloroplast, but the small forms of *C. subcostatum* have likewise but one pyrenoid.

201. **Cosmarium subprotumidum** Nordst.

(Pl. LXXXVI, figs. 19–21.)

Cosmarium subprotumidum Nordst. Desm. Ital. 1876, p. 38, t. 12, f. 14; De Toni, Syll. Alg. 1889, p. 1010; West, Danish Algæ, 1891, p. 420; Alg. Engl. Lake Distr. 1892, p. 728; Nordst. Index Desm. 1896, p. 246; West & G. S. West, Alga-fl. Yorks. 1900, p. 77; Alg. N. Ireland, 1902, p. 39; Freshw. Alg. Orkneys and Shetlands, 1905, p. 20; G. S. West, Alg. Third Tanganyika Expedit. 1907, p. 121.
Ursinella subprotumida Kuntze, Revis. gen. plant. 1891, p. 925.

Cells small, almost as broad as long, deeply constricted, sinus narrowly linear; semicells trapeziform-subsemicircular, lower third of equal width, upper two-thirds strongly narrowed towards the apex, basal angles rectangular and scarcely rounded, upwardly converging parts of sides with two hollows and a median crest, the latter generally retuse or retuse-emarginate, apical angles obtuse or more frequently obliquely retuse, apex truncate and with two or four small undulations between the angles; cell-wall furnished with more or less radially arranged granules within the margin, generally in pairs just within each crenation, but single further away from the margin; with a large granulated tumour in the centre of the semicell above the isthmus, granules arranged in 3 vertical series (4 or 5 granules in each), the middle series straight (rarely duplicated) and the outer series forming arcs. Side view of semicell ovate, with a rounded apex and a large tumour near the base

on each side. Vertical view elliptic, with a prominent 3-crenulate tumour at the middle on each side. Chloroplasts axile, one in each semicell, with a central pyrenoid.

Zygospore unknown.

Length 24–30 μ; breadth 22–27 μ; breadth of isthmus 6–10 μ; thickness 17–18·5 μ.

England.—Brothers' Water, Westmoreland! Strensall, N. Yorks! Sutton Park, Warwicks!

Wales.—Near Conway, and bog near Llyn Gwynant, Carnarvonshire!

Scotland. — Skye in Inverness! Harris, Outer Hebrides! Craig-an-Lochan, Perth! Near Lerwick, and in the plankton of Loch Brindister, Shetlands!

Ireland.—Lough Cloncarney, Donegal! Ballynahinch and Derryclare Lough, Galway!

Geogr. Distribution.—Germany. Galicia in Austria. Italy. Sweden. Denmark. Central Africa.

C. subprotumidum is an uncommon British species with a decided preference for the weedy margins of lakes and large ponds. It stands nearest to *C. protumidum* Nordst. ('Desm. Spetsb.' 1872, p. 34, t. 7, f. 18), but is distinguished by its somewhat different lobulation, by the reduction of the marginal granules, by the different arrangement of the granules as a whole, and by the less prominent central protuberance. It should also be compared with *C. costatum* Nordst. and with *C. subalatum* W. & G. S. West.

The peripheral granules of *C. subprotumidum* are generally very minute and not easily discernible. It is possible to observe all stages between slightly retuse and minutely bigranulate marginal crenations.

A form was observed from the West of Ireland (in small pools between Clifden and Roundstone, Galway; *vide* West, 'Alg. W. Ireland,' 1892, p. 157, t. 24, f. 21) in which the general granules were much more scattered and the central granules much less distinct than usual (Pl. LXXXVI, fig. 22; length 32 μ; breadth 25 μ; breadth of isthmus 8·5 μ).

Var. **Gregorii** (Roy & Biss.) W. & G. S. West.
(Pl. LXXXVI, figs. 23–25.)

C. Gregorii Roy & Biss. ined. in Gutw. Wahr. d. Priorität, 1890, p. 69; Gutw. Flor. Glon. Okolic Lwowa, 1891, p. 56; Flor. glonów Galic.

1892, p. 129, t. 3, f. 11; Roy & Biss. Scott. Desm. 1894, p. 102, t. 1, f. 11; Nordst. Index Desm. 1896, p. 135; West & G. S. West, Alg. S. England, 1897, p. 489; G. S. West, Alga-fl. Cambr. 1899, p. 218.

C. Gregorii var. *papilliferum* Gutw. Flor. Glon. Okolic Tarnapola, 1894, p. 98, t. 3, f. 34.

C. subprotumidum Nordst. var. *Gregorii* (Roy & Biss.) W. & G. S. West, Alga-fl. Yorks. 1900, p. 77; Alg. N. Ireland, 1902, p. 39.

Crenations more distinctly bigranulate than in the type, marginal granules sometimes prominent and conical in form; central granules somewhat reduced, generally in 3 vertical series of 3–4 granules in each series.

Length 23–29 μ; breadth 21–27 μ; breadth of isthmus 6·3–8 μ; thickness 12–15·5 μ.

England.—Brothers' Water, Westmoreland! Roundhay Park, Leeds, W. Yorks! Pilmoor, N. Yorks! Hornsea Mere, E. Yorks! Sutton, Sutton West Fen, and between March and Guyhirne, Cambridgeshire! Puttenham Common, Surrey! Slapton Sands, Devonshire!

Scotland.—Iron Hill, Banffshire; Collieston and Castleton, Braemar, Aberdeen; Loch Lundie, Perth; Wigtown (*Roy & Bissett*).

Ireland.—Lough Gartan, Donegal! Near Westport and near Foxford, Mayo!

Geogr. Distribution.—Galicia in Austria.

It is quite impossible to separate *C. Gregorii* as a species distinct from *C. subprotumidum*, and we imagine that Messrs. Roy and Bissett, and also Gutwinski, must have entirely overlooked the latter when they published descriptions and figures of the former.

The var. *Gregorii* differs only in the slight reduction of the central protuberance (and its attendant granules) and in the more conspicuously bigranulate marginal crenations.

Schmidle has recently described an African Desmid under the name of "*C. occultum*" (consult Schmidle, 'Alg. aus Nyassa-See,' 1903, p. 69, t. 1, f. 25) which appears to us to be scarcely separable from some of the forms of *C. subprotumidum*, but his published figure is not very good. It should also be remembered that *C. subprotumidum* is known from three localities in Central Africa, one of which is on the margin of Lake Nyassa (consult G. S. West, 'Alg. Third Tanganyika Expedit.' 1907, p. 121).

202. **Cosmarium Boeckii** Wille.
(Pl. LXXXVI, figs. 26–32.)

Cosmarium Boeckii Wille, Norges Ferskv. Alg. 1880, p. 28, t. 1, f. 10; Boldt, Siber. Chlorophy. 1885, p. 106; Cooke, Brit. Desm. 1887, p. 111, t. 42, f. 4 [figure bad]; Nordst. Bornh. Desm. 1888, p. 196; De Toni, Syll. Alg. 1889, p. 1024; West, Alg. N. Wales, 1890, p. 290; Heimerl. Desm. alpin. 1891, p. 597; West, Alg. W. Ireland, 1892, p. 157; Alg. Engl. Lake Distr. 1892, p. 728; Schmidle, Alg. Geb. Oberrheins, 1894, p. 551, t. 28, f. 10; Roy & Biss. Scott. Desm. 1894, p. 42; West & G. S. West, Some N. Amer. Desm. 1896, p. 251, t. 15, f. 7 [forma]; Alg. S. England, 1897, p. 489; Alga.-fl. Yorks. 1900, p. 77; Börg. Freshw. Alg. Færoës, 1901, p. 226; West & G. S. West, Alg. N. Ireland, 1902, p. 38; Freshw. Alg. Orkneys and Shetlands, 1905, p. 20.

Ursinella Boeckii Kuntze, Revis. gen. plant. 1891, p. 924.

Cosmarium anisochondrum Nordst. forma Borge, Beiträge Alg. Schweden, 1906, p. 32, t. 2, f. 17.

Cells somewhat small, very slightly longer than broad, very deeply constricted, sinus narrowly linear; semicells trapeziform-semicircular, lateral margins convex, incised-crenate, crenations 3, upper and lower emarginate, middle crenation entire and subacute, apex truncate, and 4–5 (generally 5)-undulate-nodulose, with two series (rarely only one) of granules within the margin, with more granules in the outer series than in the inner; in the centre with a rather slight but broad tumour, usually furnished with 4 granules disposed in a cruciate manner, lower granule situated immediately above the isthmus and often stronger than the others. Side view of semicell obovate-circular, margin with 9–12 granules. Vertical view elliptic, poles 5-granulate, with a slight and broad 3-granulate tumour on each side. Chloroplasts axile, with one pyrenoid.

Zygospore unknown.

Length 29–38 μ; breadth 27–35·5 μ; breadth of isthmus 8–13 μ; thickness 17–19 μ.

England.—Cumberland! Westmoreland! (*Bissett*). W. and N. Yorks! Cheshire (*Roy*). Leicestershire (*Roy*). Surrey! Kent! Hants! Cornwall!

Wales.—Capel Curig, Llyn Ogwen, Yr Orsedd, and Moelfre, Carnarvonshire!

Scotland.—Sutherland! Ross, Inverness (in Skye),

Banff, Aberdeen !, Kincardine, Forfar, Perth !, Stirling (*Roy & Bissett*). Orkneys ! Shetlands !

Ireland.—Donegal ! Galway ! Kerry ! Armagh ! Down ! Londonderry !

Geogr. Distribution.—France. Germany. Galicia in Austria. Norway. Denmark. Sweden. Bornholm. Poland. Faeroes. Iceland. Japan. United States.

C. Boeckii is widely distributed in the British Islands, occurring both in bogs and at the weedy margins of ponds and lakes. The peculiar crenation of the lateral margins of the semicells is very characteristic, although to a certain extent resembling that of *C. quinarium*. The central granules are normally four in number and disposed in the form of a cross, but they are subject to considerable variation. One or more of them may be duplicated either in a vertical or longitudinal direction. This variation, however, does not obliterate the general disposition, which still remains fairly evident. We have illustrated some of these various dispositions of central granules in figs. 27–32, pl. LXXXVI.

203. **Cosmarium calcareum** Wittr.
(Pl. LXXXVII, figs. 1, 2.)

Cosmarium calcareum Wittr. Gotl. Öl. sötv. Alg. 1872, p. 58, t. 4, f. 13; Cooke, Brit. Desm. 1886, p. 94, t. 37, f. 12; Boldt, Desm. Grönland, 1888, p. 23; De Toni, Syll. Alg. 1889, p. 1047; Roy & Biss. Scott. Desm. 1894, p. 44; Nordst. Index Desm. 1896, p. 71; Bohlin, Flor. Algol. d'eau douce d. Açores, 1901, p. 65; Borge, Süsswasseralgen Süd-Patagon. 1901, p. 26, t. 1, f. 9 [forma]; Alg. erst. Regnell. Exped. II. Desmid. 1903, p. 101; West & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 20.

Ursinella calcarea Kuntze, Revis. gen. plant. 1891, p. 924.

Cells small, a little longer than broad, very deeply constricted, sinus narrowly linear; semicells trapeziform-semicircular, basal angles subrectangular, sides convex, lower half of sides minutely 4-crenulate, upper half with one emarginate crenation, apical angles scarcely obtuse, apex truncate and straight, minutely 6–7-crenulate, minutely granulate within the margins, granules disposed in radiating series and extending almost or quite to the central tumour, in the centre with a very small granulate tumour, 8–11 peripheral granules surrounding 1–4 central ones. Side view of semicell ovate, with 3–4 pronounced marginal granules

near the base on each side. Vertical view rather narrowly elliptic, with a small 3–4-granulate tumour at the middle on each side. Chloroplasts axile, with a central pyrenoid.

Zygospore unknown.

Length 19–30 μ; breadth 17–27·5 μ; breadth of isthmus 5–7·2 μ; thickness 11–16 μ.

England.—Leicestershire (*Roy*). Hants (*Roy*).

Scotland.—Ross, Inverness, Aberdeen, Kincardine, Forfar, Perth, Stirling, and Mull in Argyll (*Roy & Bissett*). Near Lerwick, Shetlands!

Ireland.—Dublin and Wicklow (*Archer*).

Geogr. Distribution.—S. France. Germany. Silesia in Austria. Norway. Sweden. Denmark. Iceland. Greenland. E. Africa. Azores. United States. Brazil (var.). Paraguay. Patagonia.

This small species is closely allied to *C. subcrenatum* and *C. subcostatum*, but is very much rarer than either. It does not appear to have been very clearly understood in the past, and most of the Desmids which have been recorded under the name of *C. calcareum* should be relegated elsewhere.

Both the granulation and the central protuberance are subject to slight variation, and it is sometimes well nigh impossible to distinguish between *C. calcareum* and the smaller specimens of *C. subcostatum* forma *minor*. The only constant distinction is the presence in the latter of at least two emarginate crenations on the upper part of each lateral margin.

204. **Cosmarium subcostatum** Nordst.

(Pl. LXXXVII, figs. 3–5.)

Cosmarium subcostatum Nordst. Desm. Ital. 1876, p. 37, t. 12, f. 13; De Toni, Syll. Alg. 1889, p. 1028; Schmidle in Ber. Deutsch. Botan. Ges. x, 1892, p. 208, t. 11, f. 10–12; West, Alg. W. Ireland, 1892, p. 157; Alg. Engl. Lake Distr. 1892, p. 728; Börg. Ferskv. alg. Östgrönl. 1894, p. 12, t. 1, f. 4; Roy & Biss. Scott. Desm. 1894, p. 175; Nordst. Index Desm. 1896, p. 244; West & G. S. West, Alg. S. England, 1897, p. 489; Alga-fl. Yorks. 1900, p. 78; Börg. Freshw. Alg. Færoës, 1901, p. 226; West & G. S. West, Alg. N. Ireland, 1902, p. 39; Scott. Freshw. Plankton, I. 1903, p. 527; G. S. West, W. Indian Freshw. Alg. 1904, p. 285; Larsen, Freshw. Alg. E. Greenland, 1904, p. 89; West & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 21; Further Contrib. Plankton Scott. Lochs, 1905, p. 484; G. S. West, Alg. Third Tanganyika Expedit. 1907, p. 121.

Ursinella subcostata Kuntze, Revis. gen. plant. 1891, p. 925.

Cells rather small, about $1\frac{1}{5}$ times as long as broad, deeply constricted, sinus narrowly linear with a dilated extremity; subtrapeziform-reniform, basal angles rounded, sides convex and crenulate, with about 2 small entire crenulations near the basal angles and about 4 larger emarginate (or bigranulate) crenulations on the rest of the lateral margin, apex truncate and delicately 4-crenulate, apical angles commonly very slightly emarginate; within the margin minutely granulate, granules radially and concentrically disposed, the two or three series next the margin binate, those nearest the centre single; in the centre above the isthmus with a granulate tumour (surrounded by a small clear space), granules in 4–5 subvertical series and about 4 in each series. Side view of semicell ovate, with a tumour near the base at each side. Vertical view somewhat narrowly elliptic, with a granulate tumour at the middle on each side. Chloroplasts axile, with two pyrenoids.

Zygospore unknown.

Length 26–38 μ; breadth 23–32 μ; breadth of isthmus 6·6–12 μ; thickness 14·5–20 μ.

England.—Cumberland! Westmoreland! W., N., and E. Yorks! Essex! Cambridgeshire! Middlesex! Surrey! Kent! Cornwall!

Wales.—Llyn Ogwen, and Llanrhwchwyn near Llanwrst, Carnarvonshire!

Scotland.—Rhiconich, Sutherland! Iron Hill, Banff, near Mill of Muchells, Kincardine (*Roy & Bissett*). Perth! Lewis, Outer Hebrides! Orkneys! Neugles Water and Loch Brindister near Lerwick, Shetlands!

Ireland.—Donegal! Derryclare Lough, Galway! Lower Lake of Killarney, Kerry! Armagh! Down! Londonderry!

Geogr. Distribution.—France. Germany. Galicia in Austria. Italy. Finland. W. Russia. Faeroes. Greenland. Central China (var.). Ceylon. Central Africa (form). W. Indies.

C. subcostatum is a frequent British species, especially at the weedy margins of lakes and ponds. It is not a *Sphagnum*-species. It is closely related to *C. subcrenatum* on the one hand and to *C. costatum* on the other. In general proportions it is very similar to *C. subcrenatum*, but it differs in its more minute apical crenulations, in its more pronounced bigranulate or emarginate crenations, and in the smaller central protuberance with fewer granules. It is much more easily distinguished from *C. costatum*, having proportionately shorter cells with a much deeper constriction, more attenuated semicells, less prominent crenations, and a much smaller central protuberance.

Forma **minor** West & G. S. West. (Pl. LXXXVII, figs. 6–9.)

C. subcostatum Nordst. forma *minor* West & G. S. West, Alg. Centr. Africa, 1896, p. 379, t. 361, f. 15; Welw. Afric. Freshw. Alg. 1897, p. 122; G. S. West, Alg. Third Tanganyika Expedit. 1907, p. 121.

C. Kjellmani var. *ornatum* Wille forma Borge, Beiträge Alg. Schweden, 1906, p. 42, t. 3, f. 32.

Cells rather smaller than in the type, with only 2–3 (generally 2) emarginate lateral crenations. Chloroplasts with one pyrenoid.

Length 19–24 μ; breadth 18·5–21 μ; breadth of isthmus 4·2–5·5 μ; thickness 10·5–12·5 μ.

England.—Near Cockermouth, Cumberland!

Ireland.—Lough Derryclare, Galway!

Geogr. Distribution. — Sweden. United States. Central and W. Africa.

It is very probable that *C. subcrenatum* Hantzsch var. *divaricatum* Wille should be referred to this small form of *C. subcostatum*, as it differs only in its broader central tumour which is furnished with 6–8 vertical series of granules. *C. Kjellmani* var. *ornatum* Wille also stands very near, but the sinus is more open and the sides of the semicells are more strongly convergent to narrower apices.

The *C. calcareum* figured by Johnson ('New and Rare Desm. U. S., I,' 1894, t. 211, f. 13) should also be relegated to *C. subcostatum* forma *minor*.

Var. **Beckii** (Gutw.) *nob.* (Pl. LXXXVII, figs. 10–12.)

Cosmarium Beckii Gutw. Nagj. dosel. Bosni Hercegovin. halugam. 1896, p. 376, t. 1, f. 7; G. S. West, Alga-fl. Cambr. 1899, p. 217, t. 395, f. 11.

Semicells rather more elevated; granules of the central tumour variable (as in the type) but with a more definite concentric disposition. Chloroplasts with one pyrenoid.

Length 22–29 μ; breadth 18–25 μ; breadth of isthmus 5·4–6·6 μ; thickness 14·5–15·4 μ.

England.—Guyhirne, Cambridgeshire!

Geogr. Distribution.—Bosnia.

This form is scarcely to be separated from typical *C. subcostatum*, as the granulation of the central tumour varies in this, as in other species, to a considerable extent.

The form of *C. subcostatum* figured by Schmidle (in 'Ber. Deutsch. Botan. Ges.' x, 1892, t. 11, f. 12) is particularly interesting as it possesses the same form of semicell as Gutwinski's "*C. Beckii*" combined with a central tumour much more nearly approaching that of *C. subcostatum*.

The larger forms of *C. subcostatum* appear to possess two pyrenoids in each chloroplast, but the smaller forms only one.

205. **Cosmarium costatum** Nordst.

(Pl. LXXXVII, figs. 13–16.)

Cosmarium crenatum Ralfs subsp. *costatum* Nordst. Desm. Spetsb. 1872, p. 30, t. 6, f. 9.

C. costatum Nordst. Desm. Arctoæ, 1875, p. 25, t. 7, f. 17; Boldt, Desm. Grönland, 1888, p. 21; De Toni, Syll. Alg. 1889, p. 1012; Roy & Biss. Scott. Desm. 1894, p. 44; Schmidle, Lappmark Süsswasseralgen, 1898, p. 38, t. 1, f. 57, 59 [forma]; G. S. West, Alga-fl. Cambr. 1899, p. 218; Borge, Süsswasseralgen Franz Josefs-land, 1899, p. 763; West & G. S. West, Notes Alg. III, 1903, p. 75; Larsen, Freshw. Alg. E. Greenland, 1904, p. 84; West & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 21.

Ursinella costata Kuntze, Revis. gen. plant. 1891, p. 924.

Cells somewhat small, $1\frac{1}{5}$–$1\frac{1}{4}$ times as long as broad, fairly deeply constricted, sinus narrowly linear; semicells subtrapeziform, lower portion of equal width, upper portion some upwardly attenuated, basal angles rectangular, sides incised-crenate, crenations 4–5, one or two small and entire at the basal angles, the others emarginate, apex truncate and 4-crenate (including the apical angles), crenations emarginate; with minute granules disposed in radiating and concentric series within the margin, granules binate except the inner-

most series and those within the basal angles, in the centre above the isthmus with a large tumour furnished with 5–7 vertical granulate ridges. Side view of semicell ovate or subrectangular, inflated near the base on each side, upper angles rounded, apex convex or retuse. Vertical view elliptic, with a broad crenulate inflation on each side. Chloroplasts axile, with one pyrenoid.

Zygospore unknown.

Length 27–57·6 μ; breadth 25–39·6 μ; breadth of isthmus 10·5–21·6 μ; thickness 15–28·8 μ.

England.—Chippenham Fen, Cambridgeshire!

Wales.—Llyn Idwal, Carnarvonshire!

Scotland.—Iron Hill, Banff; Aberdeen; in Mull, Argyll (*Roy & Bissett*). Bressay, Shetlands!

Geogr. Distribution.—Galicia in Austria. Sweden. Nova Zembla. Franz Joseph Land. Greenland. Spitzbergen. United States.

This rare alpine and arctic Desmid exhibits considerable variation in size. Boldt ('Desm. Grönland,' 1888, p. 21) regards the smallest forms as forma *minor* and the largest forms as forma *major*.

Forma *minor* Boldt. Length 27–33·6 μ; breadth 25–28·8 μ; breadth of isthmus 10·5–12 μ; thickness 15–20·4 μ.

Forma *major* Boldt. (= forma *major* Schmidle, 'Lappmark Süsswasseralgen,' 1898, p. 38, t. 1, f. 58.) Length 45–57·6 μ; breadth 36–39·6 μ; breadth of isthmus 18–21·6 μ; thickness 26·4–28·8 μ.

Nordstedt has described a triangular form from Spitzbergen (var. *triquetrum* Nordst. 1875 [= *C. abnorme* var. *triquetrum* Nordst. 'Desm. Spetsb.' 1872, p. 32, t. 6, f. 15]), and Boldt has also observed it from Greenland.

The occurrence of *C. costatum* in the fens of the east of England is one of those strange facts of distribution for which as yet we can offer no explanation.

206. **Cosmarium formosulum** Hoff.

(Pl. LXXXVIII, figs. 1–3.)

? *Cosmarium Quasillus* Lund. var. *quadrifera* f. *polycrenata* Jacobs. Desm. Danem. 1876, p. 196, t. 7, f. 17 a.

C. formosulum Hoff in Nordst. Desm. Bornh. 1888, p. 194, t. 6, f. 6–7; De Toni, Syll. Alg. 1889, p. 989; Gutw. Flor. Glon. Okolic Lwowa, 1891,

p. 60; West, Alg. W. Ireland, 1892, p. 155; Nordst. Index Desm. 1896, p. 125; West & G. S. West, Alg. S. England, 1897, p. 490; G. S. West, Alga-fl. Cambr. 1899, p. 218; West & G. S. West, Alga-fl. Yorks. 1900, p. 78; Börg. Freshw. Alg. Færoës, 1901, p. 226; West & G. S. West, Alg. N. Ireland, 1902, p. 39; Scott. Freshw. Plankton, I. 1903, p. 527; G. S. West, W. Indian Freshw. Algæ, 1904, p. 285; West & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 21; Further Contrib. Freshw. Plankton Scott. Lochs, 1905, p. 484; Borge, Beiträge Alg. Schweden, 1906, p. 41.

C. gradatum Roy, Desm. Alford District, 1890, p. 203; Roy & Biss. Scott. Desm. 1894, p. 102.

Ursinella formosula Kuntze, Revis. gen. plant. 1891, p. 924.

Cells rather under medium size $1\frac{1}{8}$–$1\frac{1}{3}$ times as long as broad, very deeply constricted, sinus narrowly linear with a slightly dilated extremity: semicells trapeziform-subsemicircular, basal angles rounded, sides convex and 6–7-crenate, with the 3 superior crenations bigranulate, lower ones entire, apical angles scarcely obtuse or faintly bigranulate-emarginate, apex truncate and 4 (rarely 6–7)-crenulate, within the margin very minutely granulate, granules in concentric and radiating series, binate except in the innermost series and near the basal angles, in the centre with a broad tumour furnished with 5–7 vertical series of granules. Side view of semicell broadly ovate, strongly granulate on the tumid margins near the base on each side. Vertical view rather narrowly elliptic, poles rounded and minutely crenulate, with a broad 5–7-crenulate tumour at the middle on each side, in the centre with a rather small rectangular smooth area. Chloroplasts axile, with two pyrenoids.

Zygospore unknown.

Length 40–50 μ; breadth 34–40 μ; breadth of apex 12–17 μ; breadth of isthmus 10–15·5 μ; thickness 22–25 μ.

England.—Cumberland! Westmoreland! W., N., and E. Yorks! Cambridgeshire! Middlesex! Surrey! Kent! Hants! (*Roy*). Cornwall!

Wales.—Glyder Fawr (*Roy*), and near Bettws-y-Coed!, Carnarvonshire.

Scotland.—Caithness, Ross, Inverness!, Aberdeen!, Kincardine, Forfar, Fife, Wigtown (*Roy & Bissett*).

Sutherland! Ben Laoigh, Perth! Harris and Lewis, Outer Hebrides! Orkneys! Shetlands! Rare in the plankton.

Ireland.—Donegal! Mayo! Galway! Kerry! Down! Antrim!

Geogr. Distribution.—Galicia in Austria. Sweden. Bornholm. Faeroes. Iceland. Ecuador (var.).

C. formosulum is a frequent and widely distributed species in the British Islands, occurring in bogs and in marshy lakes, and not infrequently in the plankton. It is allied to the large forms of *C. subcostatum*, but need not be confused with them. We find it a very distinctive species, and the margin has never the incised character exhibited by *C. subcostatum*. The central tumour is similar to that of *C. costatum* although the vertical ridges are not so strongly granulate.

C. mesochondrium Schmidle ('Alg. Denver, Colorado,' 1895, p. 85, fig. 3) appears to be but a reduced form of *C. formosulum* Hoff.

Var. **Nathorstii** (Boldt) West & G. S. West.

(Pl. LXXXVIII, figs. 4, 5.)

Cosmarium Nathorstii Boldt, Desm. Grönland, 1888, p. 20, t. 1, f. 21; De Toni, Syll. Alg. 1889, p. 1021; Gutw. Flor. Glon. Okolic Lwowa, 1891, p. 59; Nordst. Index Desm. 1896, p. 180; West & G. S. West, Alg. S. England, 1897, p. 490; Some Desm. U. S. 1898, p. 307; Börg. Freshw. Alg. Færoës, 1901, p. 227; Larsen, Freshw. Alg. E. Greenland, 1904, p. 87.

Ursinella Nathorstii Kuntze, Revis. gen. plant. 1891, p. 925.

Cells proportionately a little broader; semicells with less rounded basal angles, lateral margins with 3–6 bigranulate (or emarginate) crenations, granules of central tumour stronger and more pronounced.

Length 45·6–53 μ; breadth 44·4–47 μ; breadth of isthmus 12·5–15 μ; thickness 22·8–24 μ.

England. — Sutton Park, Warwickshire! Near Chapel Wood, S.E. Surrey!

Geogr. Distribution. — Galicia in Austria (var.). Faeroes. Greenland. United States.

It does not seem possible to separate *C. Nathorstii* as a species distinct from *C. formosulum*. There is a very slight difference in external form, there are rather more of the

bigranulate crenations on the lateral margins, and the granules of the central tumour are stronger; but the general characters and the disposition of the granules are precisely the same.

207. **Cosmarium subreniforme** Nordst.

(Pl. LXXXVIII, fig. 6.)

Cosmarium subreniforme Nordst. Desm. Arctoæ, 1875, p. 24, t. 7, f. 16; Boldt, Sibir. Chlorophy. 1885, p. 105; De Toni, Syll. Alg. 1889, p. 1050; Nordst. Index Desm. 1896, p. 247; Borge, Süsswasseralgen Franz Josefsland, 1899, p. 763 [forma]; West & G. S. West, Alga-fl. Yorks. 1901, p. 220; Borge, Beiträge Alg. Schweden, 1906, p. 41, t. 2, f. 30 [forma]. *Ursinella subreniformis* Kuntze, Revis. gen. plant. 1891, p. 925.

Cells rather small, slightly longer than broad, deeply constricted, sinus narrowly linear with a widely dilated extremity; semicells reniform with a truncate apex, lateral margins 7–8-crenulate (due to small granules), apex straight and indistinctly 4–5-crenulate, within the margin with a number of minute granules more or less irregularly disposed, in the centre above the isthmus with a tumour furnished with 5 vertical series of granules. Side view of semicell very broadly subovate, with a somewhat flattened apex. Vertical view rather narrowly elliptic, granulate, granules disposed in curved transverse series, absent in the centre, with a broad granulate tumour at the middle on each side.

Zygospore unknown.

Length 36–37 μ; breadth 31–33 μ; breadth of isthmus 10–11 μ; breadth of apex 13–14 μ; thickness 22 μ.

England.—Strensall Common, N. Yorks!

Geogr. Distribution. — Poland. Sweden. Franz Joseph Land. Spitzbergen. Siberia.

This rare species is distinguished from *C. subcrenatum* by its granulate (and not crenate) margin and by the different disposition of the granules, which are never arranged in pairs. It should also be compared with *C. Sportella*, from which it differs in its unproduced and undilated apex, and in its central tumour. It differs from *C. ornatum* in the form of its semicells, with a higher apex although not produced, in its much smaller granules, and in the nature of its central tumour.

208. **Cosmarium pycnochondrum** Nordst.
(Pl. LXXXVIII, fig. 7.)

Cosmarium pycnochondrum Nordst. Desm. Arctoæ, 1873, p. 23, t. 6, f. 14; ? Wolle, Desm. U. S. 1884, p. 89, t. 19, f. 10–11; Boldt, Desm. Grönland, 1888, p. 21; De Toni, Syll. Alg. 1889, p. 1021; Roy & Biss. Scott. Desm. 1894, p. 173; Nordst. Index Desm. 1896, p. 214.
Ursinella pycnochondra Kuntze, Revis. gen. plant. 1891, p. 925.

Cells of medium size, about $1\frac{1}{5}$ times as long as broad, subhexagonal in outline, sinus very narrowly linear; semicells trapeziform, sensibly narrowed from a broad straight base to a truncate apex, basal angles obtuse, sides slightly convex and 5–6-crenate, apical angles rounded, apex 4-crenate (including the apical angles), crenations 2–3-granulate, within the margin with numerous minute granules arranged in conspicuous radiating and rather indistinct concentric series, grouped in twos or threes within the crenations; with a granulate area across the basal part of the semicells above the isthmus, granules arranged in 9–12 vertical (slightly divergent) series, and with a smooth area immediately above these granules. Side view of semicell rectangular, superior angles rounded and minutely granulate, at the base on each side with a slight granulate inflation. Vertical view elliptic-oblong, with the poles and the median portion of the sides minutely granulate. Chloroplasts axile, with two (?) pyrenoids.

Zygospore unknown.

Length 58–64 μ; breadth 48–53 μ; breadth of isthmus 20·4–24 μ; breadth of apex 21·6–27 μ; thickness 30–33 μ.

Scotland.—Mount Keen and Colonel's Bed (Braemar), Aberdeen; Den of Garrol, Kincardine; Clova Tableland, Forfar (*Roy & Bissett*).

Geogr. Distribution. — Greenland. Spitzbergen. United States (?).

This alpine and arctic Desmid differs from *C. speciosum* in the much greater width of the cells as compared with their length, and in the denser nature of its granulation. As in

C. speciosum there is scarcely any appreciable inflation at the base of the semicells.

209. **Cosmarium pulcherrimum** Nordst.

(Pl. LXXXVIII, fig. 9.)

Cosmarium pulcherrimum Nordst. Desm. Brasil. 1870, p. 213, t. 3, f. 24; Lund. Desm. Suec. 1871, p. 34 [forma]; ? ? Wolle, Desm. U. S. 1884, p. 90, t. 49, f. 25–27; Schaarschm. Afghan. Alg. 1884, p. 246; Hansg. Prodr. Algenfl. Böhm. 1888, p. 201; De Toni, Syll. Alg. 1889, p. 1016; Börg. Desm. Brasil. 1890, p. 38; Roy & Biss. Scott. Desm. 1894, p. 172; Nordst. Index Desm. 1896, p. 211; Schmidle in Engler, Bot. Jahrbüch. xxx, 1901, p. 251.

Ursinella pulcherrima Kuntze, Revis. gen. plant. 1891, p. 925.

Cosmarium pulcherrimum a. typica Turn. Freshw. Alg. E. India, 1893, p. 73.

Cells somewhat under medium size, about $1\frac{1}{2}$ times as long as broad, elliptic in general outline, very deeply constricted, sinus very narrowly linear; semicells semi-elliptic, basal angles rectangular and slightly obtuse, margin crenulate, crenations 18–20, those near the basal angles being smaller than the rest, each crenation furnished with a pair of very minute marginal granules; within the margin with 4 concentric series of extremely minute granules, arranged in pairs, and also in distinct radial series; in the centre above the isthmus with a small granulate tumour, granules small and arranged in 5 vertical (and slightly converging) series. Vertical view rather narrowly elliptic, granules arranged in curved transverse series, and with a small granulate tumour at the middle on each side. Chloroplasts axile, with two pyrenoids.

Zygospore unknown.

Length 45–51 μ; breadth 32–34 μ; breadth of isthmus 7·6 μ; thickness 21 μ.

Wales.—Glydyr Fawr, Carnarvonshire (*Roy*).

Scotland.—Canlochan, Forfar (*Roy & Bissett*).

Geogr. Distribution.—Germany. Galicia in Austria. Hungary. Norway (var.). Sweden. Russian Lapland. N. Russia. Nova Zembla. Spitzbergen (var.). Greenland. Japan. Afghanistan. India. Sumatra (var.). E. Africa. United States. Brazil. Argentina.

C. pulcherrimum differs principally from its close allies, *C. binum* and *C. subspeciosum*, in its deeper constriction and in the broadly rounded apices of its semicells. Its central tumour is considerably smaller than that of *C. binum*, but is similar in general aspect to that of *C. subspeciosum*.

210. **Cosmarium binum** Nordst.

(Pl. LXXXVIII, figs. 10–14.)

Cosmarium binum Nordst. in Wittr. & Nordst. Alg. Exsic. 1880, no. 383; fasc. 21, 1889, p. 39; De Toni, Syll. Alg. 1889, p. 993; Lütkem. Desm. Attersees, 1893, p. 559; Nordst. Index Desm. 1896, p. 61; West & G. S. West, Freshw. Alg. Ceylon, 1902, p. 171; Borge, Alg. erst. Regnell. Expedit. II. Desmid. 1903, p. 101, t. 3, f. 31 [forma]; G. S. West, Alg. Third Tang. Expedit. 1907, p. 121.

C. binum Nordst. var. Racib. Desm. Nowe, 1889, p. 93, t. 5, f. 25.

C. pulcherrimum Nordst. var. *truncatum* Gutw. Wahr. d. Priorität, 1890, p. 70; Flor. Glon. Okolic Lwowa, 1891, p. 58, t. 2, f. 21; Schmidle, Alg. aus Sumatra, 1895, p. 304, t. 4, f. 11.

Ursinella bina Kuntze, Revis. gen. plant. 1891, p. 924.

Cosmarium costatum as figured by Johnson, Rare Desm. U. S. II, 1895, p. 293, t. 240, f. 31.

Cells of medium size or less, $1\frac{1}{5}$–$\frac{1}{3}$ times as long as broad, deeply constricted, sinus very narrowly linear with a slightly dilated extremity; semicells pyramidate-trapeziform, basal angles rounded-subrectangular, sides moderately convex and 6–10-crenate, apex rather widely truncate and 5–6-crenate, all the crenations (both apical and lateral) bigranulate or more or less distinctly emarginate; towards the margins granulate, granules arranged in radial and concentric series, outer three or four series binate, the remainder single; in the centre above the isthmus with a conspicuous tumour furnished with 6–8 vertical granulate ridges, and under this tumour immediately adjacent to the isthmus with a horizontal series of 5–8 rounded granules. Side view of semicell ovate-oblong, with a granulate tumour on each side near the base. Vertical view elliptic-oblong, poles rounded, with a large, rounded, granulate tumour at the middle on each side. Chloroplasts axile, with two pyrenoids.

Zygospore unknown.

Length 41–90 μ; breadth 30–59 μ; breadth of

apex 18–24 μ; breadth of isthmus 12–21 μ; thickness 27–46 μ.

Scotland.—Rhiconich, Sutherland!

Geogr. Distribution.—Austria. Poland. Ceylon. Sumatra. Central Africa. Brazil. Australia. United States.

C. binum has a wide distribution and exhibits much variability in size in different localities. It is somewhat rare in temperate climates, but it is the most frequent of the *C. speciosum*-group in the tropics. The larger forms possess more marginal crenations than the smaller forms, but differ in no other points, and as all intermediate states exist between those with 17 and those with 26 marginal crenations per semicell, we have not discriminated between them.

One of the principal features of *C. binum* is its central tumour, which consists of a large rounded inflation traversed by a number of vertical ridges. Each ridge is notched at regular intervals and thus cut up into a number of more or less quadrangular granules. Beneath the tumour, and somewhat isolated from it, is a single (very rarely a double) series of rounded granules. These granules are generally conspicuous, and we have regarded the combination of this basal series of granules with the type of tumour just described as the diagnostic feature of *C. binum*.

C. binum should be compared very carefully with *C. pulcherrimum* and with *C. subspeciosum*. From the former it is distinguished by its truncate apices, and by its larger, differently granulated tumour, with the distinct isolated series of basal granules. From the latter it differs in the broader truncate apices, with more crenations, in the more regularly binate granulation of all the marginal crenations, and in the nature of its central tumour.

There is a smooth area between the central tumour and the radial granules, and also in the centre of the apex (as seen in vertical view).

211. **Cosmarium speciosum** Lund.
(Pl. LXXXIX, figs. 1–3.)

Cosmarium speciosum Lund. Desm. Suec. 1871, p. 34, t. 3, f. 5; Wolle, Desm. U. S. 1884, p. 87, t. 19, f. 7–8; Cooke, Brit. Desm. 1887, p. 117, t. 41, f. 1; Boldt, Desm. Grönland, 1888, p. 19; West, Alg. N. Yorks. 1889, p. 293; Alg. N. Wales, 1890, p. 290; Borge, Chlor. Norska Finmark. 1892, p. 10; Racib. Desmidyja Ciastonia, 1892, p. 386, t. 6, f. 13; Lütkem. Desm. Attersees, 1893, p. 554; Nordst. Index Desm. 1896,

p. 236; West & G. S. West, Alg. S. England, 1897, p. 491; G. S. West, Alga-fl. Cambr. 1899, p. 219; West & G. S. West, Alga-fl. Yorks. 1900, p. 85; Börg. Freshw. Alg. Færoës, 1901, p. 226; West & G. S. West, Alg. N. Ireland, 1902, p. 40; Freshw. Alg. Orkneys and Shetlands, 1905, p. 22; Borge, Beiträge Alg. Schweden, 1906, p. 33.

Euastrum (*Cosmarium*) *speciosum* Gay, Monogr. loc. Conj. Montpellier, 1884, p. 62.

Dysphinctium notabile (Bréb.) Hansg. subsp. *speciosum* (Lund.) Hansg. Prodr. Algenfl. Böhm. 1888, p. 290.

D. speciosum (Lund.) Hansg. l. c. p. 187 [in note]; De Toni, Syll. Alg. 1889, p. 891; Schmidle, Lappmark Süsswasseralgen, 1898, p. 20.

Cosmarium speciosum Lund. forma *genuina* Mask. Further Notes N. Zeal. Desm. 1889, p. 16, t. 2, f. 22.

Cells of medium size or slightly under, about $1\frac{1}{2}$ times as long as broad, moderately constricted, sinus very narrowly linear; semicells subrectangular, basal angles scarcely rounded, very gradually attenuated upwards, apical angles rounded, apex truncate, margin crenate, crenations 17–19 (4 apical and about 7 lateral); granulate within the margin, granules in regular radial and concentric series, 3–4 granules in each radial series; with 6–9 vertical series of granules across the base just above the isthmus, 4–5 granules in each series. Side view of semicell ovate-oblong, with a broadly rounded apex. Vertical view elliptic, poles very delicately crenulate, granules disposed in curved transverse series. Chloroplasts axile, one in each semicell with a central pyrenoid.

Zygospore unknown.

Length 54–64 μ; breadth 37–41 μ; breadth of isthmus 20–26 μ; thickness 25–28 μ.

England.—Westmoreland! (*Bissett*). W. and N. Yorks! Epping Forest, Essex! Chippenham Fen, Cambridge! Hants (*Bennett*). Near the Lizard!, Cornwall (*Bennett*).

Wales.—Capel Curig, Bettws-y-Coed, Llyn Idwal, Yr Orsedd, Penmaenmawr, and at 3000 ft. on Snowdon, Carnarvonshire! Rhos Goch Bog, Radnorshire!

Scotland.—Aberdeen!, Forfar!, Stirling (*Roy & Bissett*). Skye in Inverness! Harris, Outer Hebrides! Hoy, Orkneys! (Also in the plankton of Loch Kirbister.) Near Scalloway, and in Bressay, Shetlands!

Ireland.—Lough Beg, Londonderry! Dublin and Wicklow (*Archer*). Carrantuohill, Kerry! Mourne Mts., Down!

Geogr. Distribution.—France. Germany. Austria and Galicia. Bosnia (var.). Italy. Norway. Sweden. Denmark. Bornholm. Finland. S. Russia. Faeroes. Nova Zembla. Franz Joseph Land. Spitzbergen. Greenland. Australia (var.). New Zealand. S. Africa. Sandwich Islands (var.). United States. Argentina. Patagonia (var.).

C. speciosum is principally an upland species, occurring in mountainous districts in boggy springs and on dripping rocks, in which situations it is frequently associated with *C. Holmiense, C. anceps, C. notabile, C. galeritum,* etc.

Nordstedt, on examining Swedish specimens sent to him by Lundell, found the marginal crenations to be bigranulate. This form he also observed from Spitzbergen, but associated with it was another form with entire crenations and an absence of the basal granulations. He thereupon divided the *C. speciosum*-forms into "*α biforme*" and "*β simplex*" (*vide* Nordst. 'Desm. Spetsb.' 1872, pp. 30–31). We find a British form, however, with entire crenations and distinct basal granules, thus agreeing exactly with Lundell's original description and figure. This form we therefore regard as the type (consult Pl. LXXXIX, figs. 1–3; fig. 1 is a copy of Lundell's original figure; figs. 2 and 3 are drawn from Yorkshire specimens), and consequently we are compelled to consider Nordstedt's "*α biforme*" and "*β simplex*" as varieties of it.

One of the features of typical *C. speciosum* is the absence of a basal tumour, the semicells not being inflated in the region of the basal granules.

The zygospore of the typical form is not known, but Raciborski has observed the zygospore of an Australian variety (consult *C. speciosum* var. *difficile* Racib. 'Desmidyja Ciastonia,' 1892, p. 375, t. 6, f. 16). This zygospore was broadly ellipsoid, with the poles somewhat irregularly produced, and the wall was ornamented with large scattered scrobiculations.

Var. **biforme** Nordst. (Pl. LXXXIX, figs. 4, 5.)

C. speciosum Lund. *α biforme* Nordst. Desm. Spetsb. 1872, p. 30, t. 6, f. 11; Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 41; Boldt, Desm. Grönland, 1888, p. 20; West, Alg. Engl. Lake Distr. 1892, p. 728; Lütkem. Desm.

Attersees, 1893, p. 554; Roy & Biss. Scott. Desm. 1894, p. 174; Börg. Ferskv. Alg. Östgrönl. 1894, p. 15; Borge, Süsswasseralgen Franz Josefs-land, 1899, p. 761; West & G. S. West, Alga-fl. Yorks. 1900, p. 85; Börg. Freshw. Alg. Færoës, 1901, p. 226; Larsen, Freshw. Alg. E. Greenland, 1904, p. 88.

Cells often larger than the type, crenations bigranulate (except for 2 or 3 or the smaller ones near the basal angles), with about 3 concentric series of binate granules within the margin (also radially arranged), the rest single; with 9–13 vertical series of granules forming the granulated band across the base of the semicells. Vertical view with a slight but broad swelling at each side.

Length 61–81 μ; breadth 43–58 μ; breadth of isthmus 25–32·5 μ; thickness 28–35 μ.

England.—Kirk Fell, Westmoreland! Arncliffe and Penyghent, W. Yorks!

Scotland.—Near Scalloway, Shetlands!

Ireland.—Achill Island, Mayo!

Geogr. Distribution. — Austria., Norway. Nova Zembla. Spitzbergen. Franz Joseph Land. Greenland. Faeroes.

Var. **simplex** Nordst. (Pl. LXXXIX, fig. 6.)

C. speciosum Lund. β *simplex* Nordst. Desm. Spetsb. 1872, p. 31, t. 6, f. 12; Desm. Arctoæ, 1875, p. 22; Desm. Ital. 1876, p. 37; Alg. aq. dulc. et Char. Sandvic. 1878, p. 12; Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 41; Boldt, Desm. Grönland, 1888, p. 20; Mask. Further Notes N. Zeal. Desm. 1889, p. 16, t. 2, f. 23; West, Alg. W. Ireland, 1892, p. 159; Roy & Biss. Scott. Desm. 1894, p. 175; Börg. Ferskv. Alg. Ostgrönl. 1894, p. 15; West & G. S. West, Alga-fl. Yorks. 1900, p. 85; Larsen, Freshw. Alg. E. Greenland, 1904, p. 89.

Semicells more attenuated towards the apex than in the type, crenations entire and all the granules simple, basal vertical series of granules commonly very indistinct or absent.

Length 42–60 μ; breadth 30–40 μ; breadth of isthmus 14–20 μ; thickness 21–26 μ.

England.—Penyghent, W. Yorks! Mickle Fell and Cowgill Wold Moss on Widdale Fell, N. Yorks!

Scotland.—Ross, Inverness, Banff, Aberdeen, Kin-

cardine, Forfar!, Perth!, Stirling, Argyll (*Roy & Bissett*).

Ireland.—Carrantuohill, Kerry!

Geogr. Distribution. — France. Italy. Norway. Sweden. Finland. N. Russia. Nova Zembla. Spitzbergen. Greenland. Sandwich Is. New Zealand.

The average number of crenations on a semicell of this variety is 20, but some of the smaller forms may only possess 16. Occasionally some of these crenations are very delicately bigranulate, but this can scarcely be detected except in the side or vertical view.

Two smaller forms of this variety have been recorded by Wille ('Ferskv. Alg. Nov. Semlj.' 1879, p. 41) from Nova Zembla, and have been seen by others from elsewhere.

Forma *minor* Wille, l. c. t. 12, f. 28. Length 28–30 μ; breadth 20–24 μ; breadth of isthmus 16 μ; thickness 17–18 μ. We have not observed this small form in the British Islands.

Forma *intermedia* Wille, l. c. t. 12, f. 29; Boldt, Desm. Gronland, 1888, p. 20; Borge, Chlor. Norska Finmark. 1892, p. 10; West & G. S. West, Alga-fl. Yorks. 1900, p. 85. Length 38–40 μ; breadth 27–28 μ; breadth of isthmus 14–17 μ; thickness 20–25 μ. (Pl. LXXXIX, fig. 7.) We have observed this form from Woolley, West Yorkshire.

Var. **Rostafinskii** (Gutw.) *nob.* (Pl. LXXXIX, figs. 8–10.)

Cosmarium Rostafinskii Gutw. Wahr. d. Priorität, 1890, p. 67; Flor. Glon. Okolic Lwowa, 1891, p. 41, t 1, f. 15; Nordst. Index Desm. 1896, p. 225; West & G. S. West, Alga-fl. Yorks. 1900, p. 84.

Semicells rather more regularly pyramidate than in typical *C. speciosum*, and with the apex more evidently truncate.

Length 35–46 μ; breadth 23–31 μ; breadth of isthmus 11–14 μ; thickness 15·5–16·5 μ.

England.—Cautley Spout, W. Yorks!

Scotland.—Buirn Chalim, Perthshire!

Geogr. Distribution.—Galicia in Austria. United States (form).

This form differs so little from *C. speciosum* that it is scarcely justifiable to regard it as specifically distinct.

We have described from California a Desmid which we

named "*C. Rostafinskii* var. *americanum*" (*vide* W. & G. S. West, 'Some Desm. U. S.' 1898, p. 304, t. 17, f. 13). This differs from the usual form in the absence of the granules above the isthmus, and should be placed as *C. speciosum* var. *Rostafinskii* forma *americana*.

212. **Cosmarium subspeciosum** Nordst.

(Pl. LXXXIX, fig. 11.)

Cosmarium subspeciosum Nordst. Desm. Arctoæ, 1875, p. 22, t. 6, f. 13; Cooke, Brit. Desm. 1887, p. 117, t. 41, f. 2; Boldt, Desm. Grönland, 1888, p. 20; De Toni, Syll. Alg. 1889, p. 986; West, Alg. N. Yorks. 1889, p. 293; Alg. N. Wales, 1890, p. 290; Alg. W. Ireland, 1892, p. 159; Alg. Engl. Lake Distr. 1892, p. 729; Roy & Biss. Scott. Desm. 1894, p. 175; Börg. Ferskv. Alg. Östgrönl. 1894, p. 16; Nordst. Index Desm. 1896, p. 247; West & G. S. West, Welw. Afric. Freshw. Algæ, 1897, p. 175; Borge, Trop. u. subtrop. Süssw.-Chlor. 1899, p. 23; West & G. S. West, Alga-fl. Yorks. 1900, p. 85; Alg. N. Ireland, 1902, p. 40; Freshw. Alg. Orkneys and Shetlands, 1905, p. 22; Borge, Beiträge Alg. Schweden, 1906, p. 42.

Ursinella subspeciosa Kuntze, Revis. gen. plant. 1891, p. 925.

Cells rather under medium size, $1\frac{1}{4}$–$1\frac{1}{3}$ times as long as broad, deeply constricted, sinus narrowly linear; semicells pyramidate-subsemicircular, from the flat base at first slightly dilated, then very gradually attenuated to the subtruncate apex, basal angles scarcely rounded, apical angles slightly rounded, margin 16–18-crenate, 4 apical crenations and 6–7 on each convex side, those crenations near the basal angles smaller than the apical ones, crenations (except those at the basal angles) minutely bigranulate; within the margins minutely granulate, granules arranged in radial and concentric series, 3 outer concentric series geminate, 2 inner series single; in the centre above the isthmus with a rounded granulate tumour, granules irregularly disposed or in 5–6 indistinct subvertical series. Side view of semicell ovate-rectangular, slightly tumid at the base on each side, apical angles slightly rounded. Vertical view elliptic, with a tumour at the middle on each side, poles rounded.

Zygospore unknown.

Length 41–50·4 μ; breadth 28·8–36 μ; breadth of isthmus 12–16·2; thickness 20–26 μ.

England.—Westmoreland! (*Bissett*). Shipley Glen

and Penyghent, W. Yorks! Mickle Fell and Scarborough Mere, N. Yorks! Leicestershire (*Roy*).

Wales.—Capel Curig, Carnarvonshire!

Scotland.—Near Mintlaw, Aberdeen; Clova Tableland and Canlochan, Forfar (*Roy & Bissett*). Craigan-Lochan and Spittal of Glen Shee, Perth! Loch Ness, Inverness! Plankton of Loch Nan Cuinne, Sutherland (*J. Murray*)! Orkneys! Shetlands!

Ireland.—Near Glenties and Lough Anna, Donegal! Creggan Lough, Galway!

Geogr. Distribution.—Galicia in Austria. Norway. Sweden. N. Russia. Faeroes. Nova Zembla. Spitzbergen. Greenland. Ceylon. Madagascar (var.). E. Africa. Newfoundland. United States. Brazil. Patagonia (var.).

C. subspeciosum is at once distinguished from *C. speciosum* by the different proportions and more pyramidate form of its semicells, as well as by its small and rounded central tumour. The two species often occur intermingled in subalpine boggy springs.

It appears to us, however, to be much more closely allied to *C. pulcherrimum*, from which it is only distinguished by the shape of the semicells, which are much less inflated and truncate at the apex. *C. binum* is also very nearly related, differing in its more conspicuously emarginate crenations, its broader apex, and in the structure of its central tumour.

Var. **validius** Nordst. (Pl. LXXXIX, figs. 12, 13.)

C. speciosum var. *inflatum* Mask. New Zeal. Desm. Add. 1883, p. 240, t. 24, f. 6 [according to Maskell, 1892].

C. subspeciosum Nordst. var. *validius* Nordst. in Botan. Notis. 1887, p. 160; Freshw. Alg. N. Zeal. 1888, p. 49, t. 5, f. 10; Borge, Süssw. Chlor. Archang. 1894, p. 31; Johnson, Rare Desm. U. S. II, 1895, p. 294, t. 240, f. 33; Borge, Trop. u. subtrop. Süssw.-Chlor. 1899, p. 23; Süsswasseralgen Süd-Patagon. 1901, p. 26.

C. subspeciosum Nordst. var. *effigiatum* West & G. S. West, Alg. Madag. 1895, p. 69, t. 7, f. 16.

Cells rather larger, semicells with 7–9 lateral crenations, and a larger basal tumour furnished with 7–9 vertical series of granules.

Length 68–84 μ; breadth 47–53 μ: breadth of isthmus 17·5–22 μ; thickness 33–34 μ.

Scotland. — Skye in Inverness! Lewis, Outer Hebrides!

Geogr. Distribution.—Galicia in Austria. United States. N. Russia. Manchuria. Madagascar. New Zealand. Patagonia.

This large handsome variety has commonly 22 crenations on each semicell. Borge has recorded forms of it with a length of only 58 μ and a breadth of 41 μ.

213. **Cosmarium speciosissimum** Schmidle.

(Pl. LXXXIX, figs. 14, 15.)

Cosmarium speciosissimum Schmidle, Beitr. alp. Alg. 1895, p. 458, t. 15, f. 30–31; Nordst. Index Desm. 1896, p. 236; Gutw. in Spraw. Kom. fizogr. Akad. Umiej. Krakow, 1898, p. 196; West & G. S. West, Alga-fl. Yorks. 1900, p. 85.

Cells rather under medium size, deeply constricted, sinus narrowly linear; semicells semi-elliptic with a broadly rounded apex, basal angles subrectangular, margin deeply crenate, crenations 12–14 (commonly 12), emarginate (or more rarely truncate); with radial and concentric series of truncate-emarginate warts within the margin, 4–7 concentric series in which the warts diminish in size from the periphery towards the centre; across the base of the semicell and immediately above the isthmus with a transverse row of 6 strong costæ (vertically disposed). Side view of semicell rectangular, basal angles tumid, sides slightly concave, apical angles rounded and minutely crenulate, apex faintly retuse. Vertical view elliptic, with a rounded, 6-crenulate tumour on each side, poles rounded and crenulate. Chloroplasts axile, one in each semicell, with a single pyrenoid.

Zygospore unknown.

Length 46–52 μ; breadth 30–36 μ; breadth of isthmus 17–19 μ; thickness 20–27 μ.

England.—Mickle Fell, N. Yorkshire!

Geogr. Distribution.—Germany. Galicia in Austria.

This species is the most characteristic of those which form the *C. speciosum*-group. The margin is more profoundly

crenate than in *C. speciosum* and allied species, and the crenations are slightly emarginate. The row of short vertically disposed ribs across the base of the semicells is also a distinctive feature, as each outstanding rib is quite smooth.

214. **Cosmarium subalatum** West & G. S. West. (Pl. XC, figs. 1–3.)

Cosmarium subalatum West & G. S. West, Alg. Madag. 1895, p. 63, t. 7, f. 31; Nordst. Index Desm. 1896, p. 243; West & G. S. West, Alg. Burma, 1908, p. 207.

C. alatum as recorded by West & G. S. West, Welw. Afric. Freshw. Alg. 1897, p. 122; Alg. S. England, 1897, p. 489; Alga-fl. Yorks. 1900, p. 87. [Not *C. alatum* Kirchn. 1878.]

Cells small, $1\frac{1}{6}$–$1\frac{1}{4}$ times as long as broad, deeply constricted, sinus narrowly linear with a slightly dilated extremity; semicells widely truncate-pyramidate, sides 3-crenate (including the rounded basal and apical angles), crenations of equal size, or the basal one very slightly larger than the median and apical crenations, apex truncate and 4-crenate (including the apical angles), the two crenations between the apical angles considerably smaller than the angles themselves, all the crenations bigranulate except the basal ones which are trigranulate; within the margin minutely granulate, granules in radiating and subconcentric series, usually binate just within the crenations; in the centre with a rounded granulate tumour, 7–8 granules disposed in a circle around a central one. Side view of semicell ovate, tumid at the base on each side, apex rounded or rounded-truncate. Vertical view elliptic, with a small 3-granulate tumour at the middle on each side, granules arranged in 10 transverse series. Chloroplasts axile, one in each semicell, with a single pyrenoid.

Zygospore unknown.

Length 18–24 μ; breadth 14·5–21 μ; breadth of isthmus 3·8–6·5 μ; thickness 10·5–11 μ.

England.—Boston Spa, W. Yorks! Pilmoor, N. Yorks! Slapton Sands, Devonshire!

Geogr. Distribution.—Central Africa. Madagascar. Burma.

This small species is exceedingly characteristic by reason of the three equal crenations at each side of the semicells and the two small ones in the middle of each apex. The basal crenations are trigranulate, but the rest are bigranulate; and the central tumour is furnished with a ring of 7 or 8 granules surrounding a single central granule. The chloroplast contains one large central pyrenoid.

We have in the past confused this species with *C. alatum* Kirchn., largely owing to the imperfect description and absence of figures of the latter. Dr. O. Kirchner has, however, very kindly placed in our hands his original figure of *C. alatum*, and there can be no longer any question of the specific distinction of *C. subalatum*.

Although *C. alatum* is not British we append a description, and also give figures, not merely of the type, but of a tropical variety of it. We hope by this means to finally clear up any doubt concerning Kirchner's *C. alatum* and its relations with *C. subalatum*.

Description of *C. alatum* Kirchner:—

Cosmarium alatum Kirchner, Alg. Schles. 1878, p. 153; De Toni, Syll. Alg. 1889, p. 1021; Nordst. Index Desm. 1896, p. 41. *C. alatum a. silesiacum* Racib. Nonn. Desm. Polon. 1885, p. 73. *Ursinella alata* Kuntze, Revis. gen. plant. 1891, p. 924. Cells small, about $1\frac{1}{5}$ times as long as broad, deeply constricted, sinus narrowly linear; semicells subpyramidate-trapeziform, with a broad flat base and a rather narrow apex, lateral margins rather markedly biundulate (with two hollows and a median crest), basal and apical angles rounded, apex slightly retuse; cell-wall granulate, granules with no definite radial arrangement, about 3–4 showing at the margin of each lobe of the semicell; in the centre with a granulate protuberance. Vertical view elliptic, with a large rounded protuberance at the middle on each side. Chlorplasts axile, each with two pyrenoids. Zygospore unknown. Length about 46 μ; breadth about 37 μ; breadth of isthmus 11 μ; thickness 24 μ. (Pl. XC, fig. 11.)

Geogr. Distribution.—Germany. Poland (var.). Ecuador (var.).

C. alatum differs from *C. subalatum* in its larger size, its sinuate rather than crenate margins, its relatively narrower and retuse (not crenate) apex, its more numerous and less regularly arranged granules, its larger, more granulated central tumour, and in the possession of two pyrenoids in each chloroplast.

The following variety is much better known than Kirchner's Silesian form :—

Var. ÆQUATORIENSE Nordst. in Wittr. & Nordst. Alg. Exsic. 1893, no. 1116; in Botan. Notis. 1893, p. 196. *Euastrum hexagonum* West & G. S. West, Alg. Centr. Africa, 1896, p. 378, t. 361, f. 10. Very slightly larger than the type, apex decidedly retuse or retuse-emarginate, granulation more restricted, granules in somewhat irregular clusters at and within the lobes (especially within the basal angles), central tumour rather smaller and with fewer granules than in the type; vertical view less tumid at the middle on each side. Length 44–53 μ; breadth 38–46 μ; breadth of isthmus 9·5–13 μ; thickness 21–24 μ. (Pl. XC, fig. 8.)

Geogr. Distribution.—Central Africa. Ecuador.

There is another variety of *C. alatum*—var. *gostyniense* Racib.—which appears to be distinguished by its wider cells and its more numerous and densely crowded granules (*vide* Racib. 'Nonn. Desm. Polon.' 1885, p. 73, t. 11, f. 17).

C. alatum var. *suboblongum* West & G. S. West ('Welw. Afric. Freshw. Alg.' 1897, p. 122, t. 370, f. 18–19) should be known as *C. subalatum* var. *suboblongum* nob.

C. alatum var. *indicum* Turn. ('Freshw. Alg. E. India,' 1893, p. 57, t. 8, ff. 36, 57) has no relationship with *C. alatum* Kirchn., but the figures may possibly be very inaccurate representations of forms of *C. subalatum*. The latter is known to occur in Burma.

215. **Cosmarium hexalobum** Nordst.

(Pl. XC, fig. 4.)

Cosmarium hexalobum Nordst. Desm. Spetsb. 1872, p. 33, t. 7, f. 16; Cooke, Brit. Desm. 1887, p. 116, t. 40, f. 10 [figure bad]; Boldt, Desm. Grönland, 1888, p. 24; De Toni, Syll. Alg. 1889, p. 1053; West, Alg. N. Wales, 1890, p. 290; Borge, Süssw. Chlor. Archang. 1894, p. 30 [forma]; Roy & Biss. Scott. Desm. 1894, p. 103; Börg. Ferskv. Alg. Östgrönl. 1894, p. 15; Nordst. Index Desm. 1896, p. 139; West & G. S. West, Alga-fl. Yorks. 1900, p. 85; Larsen, Freshw. Alg. E. Greenland, 1904, p. 85.

Ursinella hexaloba Kuntze, Revis. gen. plant. 1891, p. 924.

Cells somewhat small, about $1\frac{1}{4}$ times as long as broad, subhexagonal in outline, moderately constricted, with a narrowly linear sinus; semicells trapeziform, very gradually attenuated from a straight base to a broad apex, basal angles obtuse or obliquely sub-

truncate, sides straight and 4-crenate, crenations bigranulate (except the basal one or two), apex dilated and 4-crenate, apical angles (formed by the two lateral of the 4 crenations) prominent and rounded, crenation bigranulate (apical angles often 4-granulate); within the margins with radiating series of granules disposed in pairs within each crenation; in the centre of the semicell and towards the isthmus with a broad tumour furnished with 4–7 (commonly 6) vertical granulate ridges (3–5 granules on each ridge). Side view of semicell rectangular, slightly tumid near the base at each side, sides slightly retuse, apical angles rounded and granulate. Vertical view elliptic, with a broad crenulate tumour on each side, poles granulate.

Zygospore unknown.

Length 45–50 μ; breadth 34·8–40 μ; breadth of isthmus 18–20 μ; thickness 23·4–28 μ.

England.—Mickle Fell, N. Yorks!

Wales.—Near Bethesda, Carnarvonshire!

Scotland.—Black Isle, Ross; Koynach Moor, Presswhin, Craigendinnie, and Aboyne, Aberdeen; Den of Garrol and Dunis, Kincardine (*Roy & Bissett*). Glen Shee, Perth!

Ireland.—Dublin and Wicklow (*Archer*).

Geogr. Distribution.—Norway. Russian Lapland. N. Russia. Nova Zembla. Spitzbergen. Greenland.

This alpine and arctic Desmid is exceedingly rare in the British Islands. It occurs principally in boggy springs and other small boggy areas high up on the mountains. It appears to us to be a very distinctive species, but it should be very carefully compared with *C. costatum*, a Desmid which occurs in similar habitats.

We figure a small form of *C. hexalobum* from Penyghent, W. Yorkshire, which differs only in its dimensions and is therefore not to be included in var. *minus* Roy & Biss.; length 36μ; breadth 33μ; breadth of isthmus 18μ. (Pl. XC, fig. 6.)

Var. **minus** Roy & Biss. (Pl. XC, fig. 5.)

C. hexalobum Nordst. var. *minus* Roy & Biss. Scott. Desm. 1894, p. 103, t. 1, f. 12; West & G. S. West, Alg. S. England, 1897, p. 488; Gutw. in Spraw. Kom. fizyog. Akad. Umiej. Krakow. 1898, p. 152.

Cells a little smaller than the type, apices of semicells less dilated, and the crenations of the margin less bold; granules very minute and not evident at the margin.

Length 32–35 μ; breadth 28–30 μ; breadth of isthmus 10–11 μ.

England.—Epping Forest, Essex!

Scotland.—Presswhin in Cromar, Aberdeen (*Roy & Bissett*).

Geogr. Distribution.—Galicia in Austria.

216. **Cosmarium nasutum** Nordst.

(Pl. XC, figs. 9, 10.)

Cosmarium nasutum Nordst. Desm. Spetsb. 1872, p. 33, t. 7, f. 17; Boldt, Desm. Grönland, 1888, p. 24; De Toni, Syll. Algar. 1889, p. 1048; Borge, Chlor. Norska Finmark. 1892, p. 13; Süssw. Chlor. Archangel, 1894, p. 30; Nordst. Index Desm. 1896, p. 180; Schmidle, Lappmark Süsswasseralgen, 1898, p. 38; Hirn, Desm. Finnland, 1903, p. 10; Larsen, Freshw. Alg. E. Greenland, 1904, p. 86.

Ursinella nasuta Kuntze, Revis. gen. plant. 1891, p. 925.

Euastrum scitum West, Alg. W. Ireland, 1892, p. 141, t. 24, f. 13.

Cosmarium ornatissimum Schmidle, Alg. Bern. Alp. 1894, p. 90, t. 6, f. 12.

? *Euastrum Langei* Schmidle, Weit. Beitr. Algenfl. Rheineb. u. Schwarzwald. 1895, p. 79, t. 1, f. 15. [Schmidle's fig. 15*a* of the front view appears to us to be a tilted or oblique view.]

Cells small, about $1\frac{1}{4}$ times as long as broad, deeply constricted, sinus narrowly linear with a slightly dilated extremity; semicells trapeziform-semicircular, basal angles subrectangular, sides slightly convex and markedly 4-crenate (the basal crenation sometimes having the appearance of a fusion of two smaller crenations), apex retuse-emarginate, crenations bigranulate (sometimes almost papillate) except the two apical crenations which are 3–4-granulate (or subpapillate); within the margin granulate, granules binate (innermost often single), arranged in concentric and radiating series; in the centre above the isthmus with a rounded tumour furnished with an emarginate wart immediately adjacent to the isthmus. Side view of semicell rectangular, at the base on each side dilated and "nose-like" [hence specific name], apex truncate. Vertical view elliptic, with a slight tumour at the middle on each side, granules in transverse series, but

absent from the centre. Chloroplasts axile, with one pyrenoid (or sometimes with two ?).

Zygospore unknown.

Length 35–42 μ; breadth 28–33 μ; breadth of isthmus 8·5–13 μ; thickness 16–18 μ.

England.—Bog, 2 miles S. of Clapham, W. Yorks !

Ireland.—Carrantuohill, Kerry !

Geogr. Distribution.—Germany (var.). Hungary. Italy. Norway. Sweden. Finland. Poland (var.). Russian Lapland. N. Russia (a form). Nova Zembla. Spitzbergen. Greenland. Australia (var.). New Zealand (var.). United States.

Forma **granulata** Nordst. (Pl. XC, figs. 11, 12.)

C. nasutum forma *granulata* Nordst. Desm. Spetsb. 1872, p. 34; Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 42, t. 12, f. 30; Boldt, Desm. Grönland, 1888, p. 24; Lütkem. Desm. Attersees, 1892, p. 555; Börg. Ferskv. Alg. Östgrönl. 1894, p. 14; Roy & Biss. Scott. Desm. 1894, p. 169; West & G. S. West, Notes Alg. I, 1898, p. 334 [recorded as type]; Alga-fl. Yorks. 1900, p. 86 [recorded as type]; Larsen, Freshw. Alg. E. Greenland, 1904, p. 86.

Semicells with a narrow transverse band of 6–8 granules (generally in pairs) above the emarginate wart which lies adjacent to the isthmus.

Zygospore globose, with rather few mamilliform protuberances (about 9 visible in the periphery), each protuberance furnished with a short, thick, somewhat uncinate spine.

Length 33–50 μ; breadth 28–38 μ; breadth of isthmus 10–18 μ; thickness 16·5–26 μ; diam. zygosp. without spines 34–35 μ, with spines 45–47 μ.

England. — Cowgill Wold Moss on Widdale Fell, W. Yorks (with zygospores) !

Wales.—On dripping rocks, Glyder Fach, Carnarvonshire !

Scotland.—Corrie Etchachan on Ben Macdhui, and near the summit of Lochnagar, Aberdeen (*Roy & Bissett*).

Geogr. Distribution.—Austria. Bornholm. Finland. Greenland. Spitzbergen. Nova Zembla.

C. nasutum is one of the most characteristic of the rare alpine and arctic Desmids. It probably occurs in most of the

mountainous districts of the west coasts of the British Islands, and so far as our present scanty knowledge goes, the "forma *granulata*" would appear to be more frequently observed than the type. The zygospores were observed among various Jungermanniaceæ on dripping limestone rocks.

Var. **asperum** *nob.* (Pl. XC, fig. 13.)

Cosmarium asperum West & G. S. West, New Brit. Freshw. Alg. 1894, p. 8, t. 1, f. 21; Nordst. Index Desm. 1896, p. 53.

Cells proportionately a little narrower, margin of semicell with 10 truncate-emarginate crenations, granules within the margin more or less irregularly disposed, apex slightly emarginate in the middle; with a double row of granule-like warts across the base of the semicell.

Length 45 μ; breadth 31 μ; breadth of isthmus 12·5 μ; thickness 13·5 μ.

Scotland.—Near New Galloway, Kirkcudbright!

217. **Cosmarium eductum** Roy & Biss. (Pl. XC, figs. 14, 15.)

Cosmarium eductum Roy & Biss. in Nordst. Desm. Bornh. 1888, p. 198, t. 6, f. 8; De Toni, Syll. Alg. 1889, p. 952; Roy & Biss. Scott. Desm. 1894, p. 100, t. 1, f. 9; Schmidle, Lappmark Süsswasseralgen, 1898, p. 24, t. 1, f. 21.
Ursinella educta Kuntze, Revis. gen. plant. 1891, p. 924.

Cells rather small, subhexagonal in general outline, about $1\frac{1}{3}$ times as long as broad, somewhat deeply constricted, sinus narrowly linear, very slightly dilated at the extremity; semicells trapeziform, base somewhat subreniform, basal angles rounded, lower parts of sides strongly rounded-inflated and indistinctly 3–4-undulate, upper third of sides substraight, apex produced, truncate or scarcely convex, apical angles scarcely rounded; within the margins sparsely and very delicately granulate (or undulate-granulate), smooth in the centre. Side view of semicell ovate-circular. Vertical view broadly elliptic, margins faintly undulate (more especially towards the poles).

Cell-wall rather thick and smooth. Chloroplasts axile, with one pyrenoid.

Zygospore unknown.

Length 40–43 μ; breadth 28–32 μ; breadth of apex 17·6 μ; breadth of isthmus 12–13·5 μ; thickness 20 μ.

Scotland.—Powlair and Heughhead near Aboyne, Aberdeen; Crathes and Durris, Kircardine (*Roy & Bissett*).

Ireland.—Castletown, Kerry!

Geogr. Distribution.—Galicia in Austria (var.). N. Sweden. Bornholm. Poland (var.). United States.

This species should be compared with *C. retusum* (Perty) Rabenh. Raciborski ('Desm. Nowe,' 1889, p. 82, t. 5, f. 17) has described a "var. *tatricum*" of *C. eductum* which does not appear to us to differ in any essential point from the typical plant.

218. **Cosmarium didymochondrum** Nordst.

(Pl. XC, fig. 16.)

Cosmarium didymochondrum Nordst. Desm. Ital. 1876, p. 36, t. 12, f. 11; De Toni, Syll. Alg. 1889, p. 972; Racib. Desm. Nowe, 1889, p. 87; Roy & Biss. Scott. Desm. 1894, p. 45; West & G. S. West, Alga-fl. Yorks. 1900, p. 84; Borge in Ber. Schweiz. bot. Ges. 1901, p. 104 c. fig. [forma]; Alg. Argentina u. Boliv. 1906, p. 8.

Ursinella didymochondra Kuntze, Revis. gen. plant. 1891, p. 924.

Cells somewhat small, about $1\frac{1}{3}$ times as long as broad, deeply constricted, sinus narrowly linear with a slightly dilated extremity; semicells subsemicircular-quadrate, of the same width from the broad base to a little above the middle, then very gradually narrowed to a somewhat produced apex, sides 5–7-crenate, lower crenations small and rather indistinct, basal angles rectangular but obtuse, upper crenations distinct and larger, apex truncate and indistinctly 4-undulate; within the margin with two (rarely three) concentric series of granules (often very indistinct); in the centre immediately adjacent to the isthmus with two granules. Side view of semicell ovate. Vertical view elliptic, in the centre smooth. Cell-wall minutely punctate and

sometimes yellowish. Chloroplasts axile, with one pyrenoid.

Zygospore unknown.

Length 40–53 μ; breadth 28–38 μ; breadth of apex 12–18 μ; breadth of isthmus 10·5–15 μ; thickness 17–22 μ.

England.—Shipley Glen and Ingleton, W. Yorks!

Scotland.—Near Tain, Ross; Glen Urquhart, Inverness (*Roy & Bissett*).

Geogr. Distribution.—France. Germany. Galicia in Austria. Italy. Norway. Poland. Argentina.

This species should be compared with *C. crenatum*, *C. subnotabile*, and *C. subcrenatum*, from each of which it is distinguished by its general proportions, the form of its semicells, and its granulation. It occurs amongst mosses on dripping rocks and in other well-aerated situations.

219. **Cosmarium subnotabile** Wille.

(Pl. XC, figs. 17, 18.)

Cosmarium subnotabile Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 36, t. 12, f. 16; De Toni, Syll. Alg. 1889, p. 964; West, Alg. Engl. Lake Distr. 1892, p. 726; Nordst. Index Desm. 1896, p. 246; West & G. S. West, Alga-fl. Yorks, 1900, p. 84.

Ursinella subnotabilis Kuntze, Revis. gen. plant. 1891, p. 925.

Cells rather small, about 1½ times as long as broad, moderately constricted, sinus narrowly linear, with a slightly dilated extremity; semicells truncate pyramidate, basal angles subrectangular, sides convex and 5–6-undulate, apical angles scarcely rounded, apex truncate and faintly 4-undulate; within the margin with about two series of small granules, rather more within the basal angles, and with one series (or more?) across the base of the semicell next the isthmus. Side view of semicell broadly elliptic or subcircular-elliptic. Vertical view elliptic. Chloroplasts axile, with two pyrenoids.

Zygospore unknown.

Length 30–50 μ; breadth 21·5–34 μ; breadth of isthmus 11–15 μ; thickness 16–26 μ.

England.—Trough at Ambleside, Westmoreland! Near Settle, Penyghent, and Cautley Spout, W. Yorks!

Geogr. Distribution. — Galicia in Austria. Nova Zembla.

This species should be very carefully contrasted with *C. notabile* Bréb. and *C. Nägelianum* Bréb., especially the former, from which it differs only in the granulation of the cell-wall and in the presence of two pyrenoids in each semicell.

220. **Cosmarium tumens** Nordst.

(Pl. XC, figs. 19, 20.)

Cosmarium tumens Nordst. Desm. Spetsb. 1872, p. 36, t. 7, f. 23; Nordst. Index Desm. 1896, p. 262; West & G. S. West, Alga-fl. Yorks. 1900, p. 85.

Dysphinctium tumens (Nordst.) Hansg. Prodr. Algenfl. Böhm. 1888, p. 278; De Toni, Syll. Alg. 1889, p. 892; Gutw. Alg. præcip. Diatom., Asia central. atque in China collect. 1903, p. 205, t. 9, f. 4.

Cells rather under medium size, about $1\frac{1}{3}$ times as long as broad, moderately constricted, sinus open and acute-angled; semicells broadly subcircular-ovate, gradually narrowed from a broad, convex base to a rather narrow, subtruncate apex, sides convex, entire margin crenulate-granulate or undulate-crenulate, crenulations about 16 of which 4 are apical; towards the margin with several more or less irregular series of granules (sometimes with an indistinct radial disposition), and across the base immediately above the isthmus with 3–4 somewhat indistinct transverse series of granules, with a smooth area in the centre of the semicell. Side view of semicell ovate from a broad base, sides straight or very slightly concave, apex broadly rounded. Vertical view broadly elliptic, poles very bluntly pointed, margin crenulate, granules disposed approximately in transverse series. Chloroplasts axile, with one large central pyrenoid.

Zygospore unknown.

Length 48–51 μ; breadth 30–35 μ; breadth of isthmus 17–24 μ; thickness 27–30 μ.

England.—Ingleton, W. Yorks (on dripping limestone rocks)!

Geogr. Distribution.—Germany. Bohemia in Austria. Spitzbergen. China.

C. tumens is apparently a very rare Desmid with most characteristic features. Its inflated semicells, open sinus, and peculiarities of granulation easily distinguish it from any other of the crenulated species.

221. **Cosmarium retusum** (Perty) Rabenh.

(Pl. XCI, figs. 1, 2.)

Euastrum (*Cosmarium*) *retusum* Perty in Mittheil. naturf. Ges. Bern. 1849, p. 173 [Not *E. retusum* Kütz., 1845 = *Arthrodesmus Incus* (Bréb.) Hass.]; Kleinst. Lebensf. 1852, p. 208, t. 16, f. 12.
Cosmarium retusum (Perty) Rabenh. Flor. Europ. Alg. III, 1868, p. 167; Lund. Desm. Suec. 1871, p. 36, t. 3, f. 3; Nordst. Norges Desm. 1873, p. 16; Jacobs. Desm. Danemark, 1876, p. 195; De Toni, Syll. Alg. 1889, p. 1003; Racib. Desmidyja Ciastonia, 1892, p. 377; Roy & Biss. Scott. Desm. 1894, p. 174; Nordst. Index Desm. 1896, p. 224; West & G. S. West, Welw. Afric. Freshw. Alg. 1897, p. 113.
Ursinella retusa Kuntze, Revis. gen. plant. 1891, p. 925.

Cells small, about $1\frac{1}{3}$ times as long as broad, very deeply constricted, sinus narrowly linear, with a slightly dilated apex; semicells subtriangular from a subreniform base, basal angles broadly rounded, sides slightly concave, apex subtruncate (very slightly convex), apical angles obtuse; cell-wall indistinctly granulate, granules rather acute, very localized and variable, 6–8 at each basal angle (about 3 marginal), 3–6 in the centre (variably disposed), and sometimes with 3 or 4 immediately within the apex, between the granules minutely punctate. Side view of semicell ovate, apex subtruncate. Vertical view rather narrowly elliptic, with two (or three) slight prominences at the middle on each side, each prominence tipped with a granule. Chloroplasts axile, with a central pyrenoid.

Zygospore unknown.

Length 30–39 μ; breadth 24–30 μ; breadth of isthmus 8–10 μ; breadth of apex 13–18 μ; thickness 13·5–18·5 μ.

Scotland.—Glen Clunie in Braemar, and Birse, Aberdeen (*Roy & Bissett*).

Geogr. Distribution.—France. Galicia in Austria. Hungary. Norway. Sweden. Denmark. Java. Japan. Bengal. Burma. Central Africa. Australia. New Zealand. United States.

C. retusum is a rare species of characteristic form. The granulation, which is somewhat peculiar, is exceedingly variable, and not infrequently scarcely visible. It is apparently more abundant in tropical and subtropical regions than in temperate zones.

Messrs. Roy and Bissett have described a perfectly smooth variety (var. *læve*) from Japan (consult Roy & Biss. 'Jap. Desm.' p. 195).

In view of the great variability of the granulation of this species it is doubtful whether "var. *vagans*" Nordst. ('Alg. et Char. I,' 1880, p. 5, t. 1, f. 5) should not be included with the type.

Var. **angustatum** *nob.* (Pl. XCI, fig. 3.)

C. eductum Roy & Biss. var. *angustatum* West, Alg. W. Ireland, 1892, p. 143, t. 20, f. 20.

Cells proportionately narrower, basal angles indistinctly 3-undulate; cell-wall faintly but distinctly (and somewhat distantly) punctulate, punctulations stronger within the basal angles and immediately below the apex.

Length 30 μ; breadth 21·5 μ; breadth of isthmus 6·5 μ; breadth of apex 11–12·5 μ.

Ireland.—Ballynahinch, Galway!

This variety seems to be a transitional form between *C. retusum* (Perty) Rabenh. and a Desmid which we have described as *C. inæqualipellicum* (*vide* West & G. S. West, 'Alg. Madag.' 1895, p. 54, t. 6, f. 28–29), which has a wide distribution in the tropical and subtropical regions of both the eastern and western hemispheres. *C. retusum* var. *angustatum* has the same proportions as *C. inæqualipellicum*, but has neither the unequally thickened basal angles nor the minutely undulate apex of that species. The cell-wall is also differently punctulated, the punctulations of *C. inæqualipellicum* having a denser and a perfectly even disposition.

Owing to the close relationship which *C. inæqualipellicum* bears to *C. retusum* we have given figures of the former for the purpose of comparison (*vide* Pl. XCI, figs. 4 and 5). Schmidle ('Alg. aus Nyassa-See,' 1903, p. 68) has placed it as "*C. retusiforme* var. *inæqualipellicum*," but in this he has made a decided error, as it is much more closely allied to *C. retusum*, and might with justice be regarded as "*C. retusum* var. *inæqualipellicum* nob."

222. **Cosmarium ovale** Ralfs.

(Pl. XCII, fig. 1; Pl. XCIII, fig. 1; Pl. XCIV, fig. 1.)

Cosmarium ovale Ralfs, Brit. Desm. 1848, p. 98, t. 15, f. 9 [Ralfs in Ann. Mag. Nat. Hist. 1844, p. 394, t. 11, f. 7, refers to several species of the genus; Hass. Brit. Freshw. Alg. 1845, p. 366, t. 86, f. 8, 9, = copy of Ralfs, 1844]; Kütz. Spec. Alg. 1849, p. 175; Arch. in Pritch. Infus. 1861, p. 733; Lund. Desm. Suec. 1871, p. 53; Delp. Desm. subalp. 1877, p. 34, t. 10, f. 1–4; Kirchn. Alg. Schles. 1878, p. 146; Wolle, Desm. U. S. 1884, p. 57, t. 13, f. 8–9; Cooke, Brit. Desm. 1887, p. 100, t. 38, f. 3; West, Alg. W. Ireland, 1892, p. 164; Roy & Biss. Scott. Desm. 1894, p. 170; Nordst. Index Desm. 1896, p. 192; West & G. S. West, Alg. S. England, 1897, p. 488; Alga-fl. Yorks. 1900, p. 82; Alg. N. Ireland, 1902, p. 37; Scott. Freshw. Plankton, I, 1903, p. 527; Further Contrib. Plankton Scott. Lochs, 1905, p. 485; Comp. Study Plankton Irish Lakes, 1906, p. 85; Borge, Beiträge Alg. Schweden, 1906, p. 30.

Cosmaridium ovale Hansg. Prodr. Algenfl. Böhm. 1888, p. 191, f. 113.

Pleurotæniopsis (*Cosmaridium*) *ovalis* (Ralfs) De Toni, Syll. Alg. 1889, p. 912.

Cells very large, $1\frac{3}{5}$–$1\frac{4}{5}$ times as long as broad, deeply constricted, sinus narrowly linear with a slightly dilated extremity; semicells ovate from a broad, flat base, the upper half considerably more attenuated than the lower half, basal angles rounded, lower half of sides convex, upper half almost straight, apex rounded but always with an indication of being subtruncate, lateral margins furnished with 19–21 large conical granules, and with a somewhat irregular series within the margin, often with quite a number of these large granules within the basal angles, margin of the extreme apex usually smooth but with one or two series of conical granules within. Side view of semicell ovate from a broadly rounded base, apex rounded; granules forming a broad band extending up the middle from the isthmus to the apex (4–5 visible at the apical margin), disposition of granules very

irregular. Vertical view elliptic, granules forming a broad median band from pole to pole (4–5 visible at the margin of each pole), disposition of granules somewhat irregular, but generally showing indications of 4–5 very irregular series. Cell-wall finely scrobiculate, and distinctly thickened in the centre of each semicell. Chloroplasts parietal, forming 4–6 broad, irregular bands extending from base to apex of each semicell; pyrenoids rather small and numerous, 9–11 in each chloroplast.

Zygospore unknown.

Length 178–222 μ; breadth 98–136 μ; breadth of isthmus 30–47 μ; thickness 74–94 μ.

England.—Bowness, Westmoreland! (*Ralfs*). Great Shunnor Fell and Strensall, N. Yorks! New Forest, Hants!

Scotland.—Rhiconich, Sutherland! Khoil, Aberdeen (*Roy & Bissett*). Ben Lawers and Craig-an-Lochan, Perth! Plankton of Loch Shiel, Inverness! Plankton of Loch Fadaghoda, Lewis, and Loch Nan Eun, N. Uist, Outer Hebrides!

Ireland.—Near Sproule's Lough, Donegal! Ballynahinch, Galway! Adrigole, Kerry! Very rare in the plankton of small lakes between Clifden and Roundstone, Galway!

Geogr. Distribution.—France. Germany. Galicia in Austria. Silesia (var.). Italy. Norway. Sweden. United States. Brazil.

Cosmarium ovale stands quite alone among European species of the genus, not merely on account of its size, but also with regard to its granulation. In the United States it is accompanied by another allied species of almost equal size—*C. dentatum* Wolle (consult West & G. S. West, 'Some N. Amer. Desm.' 1896, p. 249, t. 15, f. 10–11). There are in all four known members of the "*C. ovale*-group," the two remaining species being *C. denticulatum* Borge ('Austral. Süsswasserchlor.' 1896, p. 19, t. 3, f. 31) and *C. splendidum* Borge ('Alg. erst. Regnell. Exped. II, Desmid.' 1903, p. 99, t. 3, f. 27), both of which are amongst the largest and handsomest species of the genus. The former possesses numerous, short,

and often curved marginal spines in place of the conical granules of *C. ovale*, and is known to occur in Australia, Brazil, and Uruguay. The latter is the largest known species of the genus (length 255–260 μ; breadth 174–176 μ), and the conical granules of *C. ovale* are in this case replaced, except for a few spines at the base, by several series of emarginate warts. This large Desmid is at present only known from Paraguay.

Ralfs' figure of *C. ovale* in his 'British Desmids,' 1848, t. 15, f. 9, is not very accurate. The marginal granules are not so broad as he figures them, but more conical, and they never extend regularly over the extreme apex of the semicell; neither are they disposed in such a regular band as he portrays them in his figure of the side view.

The marginal granules or teeth are solid, and very frequently they have a decided upward curve such as is more distinctly evident in the short spines of *C. denticulatum*.

C. ovale occurs chiefly in the western British areas, more especially in the old bogs, but it is very local although sometimes fairly abundant. It occurs in the plankton of the western lake-areas.

Var. **subglabrum** West & G. S. West. (Pl. XCIV, fig. 11.)

C. ovale var. *subglabrum* West & G. S. West, Some N. Amer. Desm. 1896, p. 249, t. 15, f. 3; Alg. S. England, 1897, p. 488.

Cells a little smaller than in the type, lateral margins of semicells minutely undulate; granules few, about 2 (rarely only one) at each basal angle, 3–4 at the margin just below the apex and 1–3 within the margin near the apex; apex narrowly truncate.

Length 154 μ; breadth 88 μ; breadth of isthmus 30 μ.

England.—New Forest, Hants!

Geogr. Distribution.—United States.

223. **Cosmarium Scoticum** West & G. S. West. (Pl. XCV, figs. 1–3.)

Cosmarium Scoticum West & G. S. West, New Brit. Freshw. Alg. 1894, p. 6, t. 1, f. 23; Nordst. Index Desm. 1896, p. 230.

Cells very large, about $1\frac{1}{2}$ times as long as broad, deeply constricted, sinus narrowly linear with a

dilated extremity; semicells truncate-pyramidate, basal angles rounded, sides convex, apical angles rounded, apex truncate or narrowly truncate; cell-wall granulate; granules very small, 24–29 showing on each lateral margin, apex smooth, generally more or less concentrically disposed towards the margin but scattered in the centre of the semicells. Side view of semicell very broadly elliptic. Vertical view elliptic, ratio of axes about 1 : 1·5, granules disposed in indistinct transverse series, smooth in the centre. Chloroplasts axile, with two pyrenoids.

Zygospore unknown.

Length 130–150 μ; breadth 98–105 μ; breadth of isthmus 35–46·5 μ; thickness 62·5 μ.

Scotland.—Ben Laoigh, Craig-an-Lochan, and Glas Mhoel, Perthshire!

This species occurred in bogs amongst numerous other Desmids. It should be compared with *C. pyramidatum* Bréb. and *C. pseudopachydermum* Nordst., from both of which it differs in the form of its semicells and in its finely granulate cell-wall.

224. **Cosmarium tetraophthalmum** Bréb.

(Pl. XCV, figs. 4–7.)

Cosmarium tetraophthalmum Bréb. in Ralfs' Brit. Desm. 1848, p. 98, t. 17, f. 11 [figures not accurate]; t. 33, f. 8; Kütz. Spec. Alg. 1849, p. 175; De Bary, Conj. 1858, p. 54; Arch. in Pritch. Infus. 1861, p. 732; Rabenh. Flor. Europ. Algar. III, 1868, p. 159; Delp. Desm. subalp. 1877, p. 26, t. 9, f. 1–4 [figures not accurate]; Klebs, Desm. Ostpreuss. 1879, p. 41; Boldt, Siber. Chlorophy. 1885, p. 108; Cooke, Brit. Desm. 1887, p. 99, t. 38, f. 1 [figure bad]; Hansg. Prodr. Algenfl. Böhm. 1888, p. 200; Boldt, Desm. Grönland, 1888, p. 28; De Toni, Syll. Alg. 1889, p. 981; West, Alg. N. Wales, 1890, p. 289; Börg. Desm. Brasil. 1890, p. 37; Gutw. Flor. Glon. Okolic Lwowa, 1891, p. 51; West, Alg. W. Ireland, 1892, p. 151; Alg. Engl. Lake Distr. 1892, p. 726; Lütkem. Desm. Attersees, 1893, p. 556; Roy & Biss. Scott. Desm. 1894, p. 176; Nordst. Index Desm. 1896, p. 253; West & G. S. West, Alg. S. England, 1897, p. 488; G. S. West, Alga-fl. Cambr. 1899, p. 217; West & G. S. West, Alga-fl. Yorks. 1900, p. 82; Bohlin, Flor. Algol. d'eau douce d. Açores, 1901, p. 65; Börg. Freshw. Alg. Færoës, 1901, p. 228; West & G. S. West, Alg. N. Ireland, 1902, p. 37; Larsen, Freshw. Alg. E. Greenland, 1904, p. 89; West & G. S. West, Freshw. Alg. Orkneys and Shetlands, 1905, p. 21; Further Contrib. Plankton Scott. Lochs, 1905, p. 485; Comp. Study Plankton Irish Lakes, 1906, p. 85; Borge, Beitr. Alg. Schweden, 1906, p. 30.

Didymidium (*Cosmarium*) *tetraophthalmum* Reinsch, Algenfl. Frank. 1867, p. 121.
Cosmarium tetraophthalmum forma Lund. Desm. Suec. 1871, p. 27.
C. tetraophthalmum Bréb. var. *Lundellii* Wittr. Gotl. Öl. sötv. Alg. 1872, p. 56; Nordst. Desm. Arctoæ, 1875, pp. 17, 40; Desm. Grönland, 1885, p. 7; Boldt, Desm. Grönland, 1888, p. 28; Gutw. Flor. Glon. Galic. 1890, p. 14; Anderss. Sverig. Chlor. 1890, p. 14; Borge, Chlorophy. Norska Finmark. 1892, p. 9; West, Alg. W. Ireland, 1892, p. 152; Alg. Engl. Lake Distr. 1892, p. 726; Gutw. Flor. Glon. Okolic Tarnapola, 1894, p. 90; Roy & Biss. Scott. Desm. 1894, p. 176; West & G. S. West, Alg. S. England, 1897, p. 488; Alga-fl. Yorks. 1900, p. 82; ? Hirn, Desm. Finnland, 1903, p. 13, t. 1, f. 16; Borge, Beiträge Alg. Schweden, 1906, p. 30.
Ursinella tetraophthalma Kuntze, Revis. gen. plant. 1891, p. 925.

Cells large, about $1\frac{1}{2}$ times as long as broad, deeply constricted, sinus narrowly linear with a dilated extremity; semicells pyramidate-ovate, basal angles very broadly rounded, sides slightly convex, extreme apex truncate and the apical angles rounded; cell-wall granulate and between the granules distinctly and finely punctate, with 12–14 large, rather flattened granules along each lateral margin, extreme apex smooth, granules within the margin large and more or less scattered (with indications of both oblique and concentric arrangements), with a gradual reduction of granules towards the centre of the semicell, where they are quite small, and also with a considerable reduction of the granules within the smooth apex. Side view of semicell almost circular. Vertical view elliptic, ratio of axes about 1 : 1·4, poles and within the poles strongly granulate, also granulate within the sides, at the middle of each side and in the centre destitute of granules. Chloroplasts axile, each with two large pyrenoids.

Zygospore ellipsoid, furnished with numerous mamillate warts (about 32 visible at the periphery), each of which is terminated by a short (often curved), simple spine.

Length 90–120 μ; breadth 60–86 μ; breadth of isthmus 18–30 μ; thickness 42–51 μ; diam. zygosp. without spines 120–137 μ, with spines 145–163 μ.

England.—Cumberland! Westmoreland! (*Ralfs*). Lancashire! W., N., and E. Yorks! Cheshire (*Roy*).

Leicestershire (*Roy*). Essex! Cambridgeshire! Gloucestershire (*Ralfs*). Surrey! (*Ralfs*). Sussex! (*Ralfs*). Kent! Hants! (*Roy*). Devon! Cornwall! (*Ralfs*).

Wales.—General in Carnarvonshire and Merioneth! Anglesey!

Scotland.—General! (*Roy & Bissett*). Orkneys! Shetlands! Very common in the Outer Hebrides!

Ireland.—General! Rare in plankton of Lough Corrib, Galway!

Geogr. Distribution.—France. Belgium. Germany. Austria and Galicia. Bosnia. Hungary. Italy. Switzerland. Norway. Sweden. Bornholm. Poland. Finland. Russian Lapland. N. Russia. Faeroes. Iceland. Spitzbergen. Greenland. Mongolia. China. Japan. India. New Zealand. Azores. United States. Brazil. Patagonia.

C. tetraophthalmum is found generally distributed over the whole of the British Islands, but more especially in *Sphagnum*-bogs and in peaty moorland ditches. It often occurs in quantity associated with *Xanthidium armatum*, *Tetmemorus granulatus*, *Gymnozyga moniliformis*, *Micrasterias denticulata*, *M. truncata*, *Euastrum Didelta*, etc. In both England and Wales it is a fairly common bog-species, but it reaches its maximum abundance in some of the boggy pools of the North-west of Scotland and the West of Ireland.

The figures of this Desmid given by Ralfs are not very accurate, and those of Delponte and Cooke are equally bad. We first pointed this out in the Journ. Roy. Microscop. Soc. 1890, p. 289. The granulation is most inaccurately figured, and the centre and apices are depicted as coarsely granulate like the rest of the semicell, which is never the case. We have examined hundreds of specimens of this species from all parts of the British Islands, including all those localities from which Ralfs (and, through the latter, Brébisson) obtained it, and we have never yet seen a specimen in which the granules were not greatly reduced both in the centre and at the apices of the semicells. Thus, the only form observed by Lundell in Sweden, and subsequently named by Wittrock as "var. *Lundellii*," is the common form throughout the whole of the British Islands, and undoubtedly the one which both Ralfs and Brébisson examined at the time the characters of the

species were laid down. We therefore regard Wittrock's "var. *Lundellii*" as the type form, and consider that this varietal name came into existence simply because careful observers were beginning to find out that their specimens did not agree with the erroneous figures given by Ralfs.* We have examined *C. tetraophthalmum* from Norway, Germany, Austria, Switzerland, and Italy, and the specimens agree in every detail with those so widely distributed in the British Islands.

C. tetraophthalmum should be carefully compared with *C. cymatopleurum* var. *tyrolicum*.

Heterocarpella tetraophthalma Kütz. ('Syn. Diat.' 1834, p. 597; Bréb. 'Alg. Falaise,' 1835, p. 56, t. 7), *Cosmarium tetraophthalmum* Menegh. ('Conspectus algol. Euganeæ,' Patav. 1837, p. 18; 'Synops. Desm.' 1840, p. 220), and *Euastrum tetraophthalmum* Kütz. ('Phyc. germ.' 1845, p. 136) are excluded from the synonymy because of the impossibility of deciding to which species of *Cosmarium* they refer.

Note.—We have excluded *C. tetraophthalmum* var. *subrotundum* West ('Alg. N. Wales,' 1890, p. 289, t. 6, f. 25) on account of its doubtful nature. The figure is not a good one, and the characters of the Desmid in question indicate relationships quite apart from *C. tetraophthalmum*. Until further specimens are examined we shall place it among those doubtful forms still to be enquired into.

* Precisely similar inaccuracies of description and figure led to the establishment of "*C. Turpinii* var. *Lundellii*," this having since been shown, by an examination of Brébisson's original specimens, to be typical *C. Turpinii* (*vide* p. 191).

NOTE ON THE PLATES.

Owing to exigencies of space it was found that the genus *Cosmarium* would have to be completed in the next volume (vol. iv). In consequence of this, the descriptions of the following species, figured in the present volume, will be found in vol. iv :

C. Grantii . . .	Pl. XCI, fig. 11.
C. Gayanum . .	Pl. XCIII, figs. 6–8.
C. latifrons . .	Pl. XCIV, fig. 6.
C. cylindricum . .	Pl. XCIV, fig. 7.
C. subcylindricum .	Pl. XCIV, fig. 8.
C. promontorium .	Pl. XCIV, fig. 9.
C. lepidum . . .	Pl. XCIV, fig. 10.

The zygospore of *C. punctulatum*, described on p. 207, is figured (fig. 22) on Pl. CII in the next volume.

EXPLANATION OF THE LETTERING.

a, *a'*, *a''*. Front view of cell or semicell.
b, *b'*. Vertical view.
c. Side view.
d. Basal view of semicell.

Plate 65

PLATE LXV.

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6.	—*C. Holmiense* var. *attenuatum* Gutw. × 400	4
7.	—*C. Holmiense* var. *undatum* West. × 400	4
8–9.	—*C. cymatopleurum* Nordst. 8, × 400 (after Nordstedt); 9, form with produced apices, approaching var. *Archerii*, × 520	5
10.	—*C. cymatopleurum* var. *Archerii* (Roy & Biss.) West & G. S. West. × 400 (after Roy & Bissett)	6
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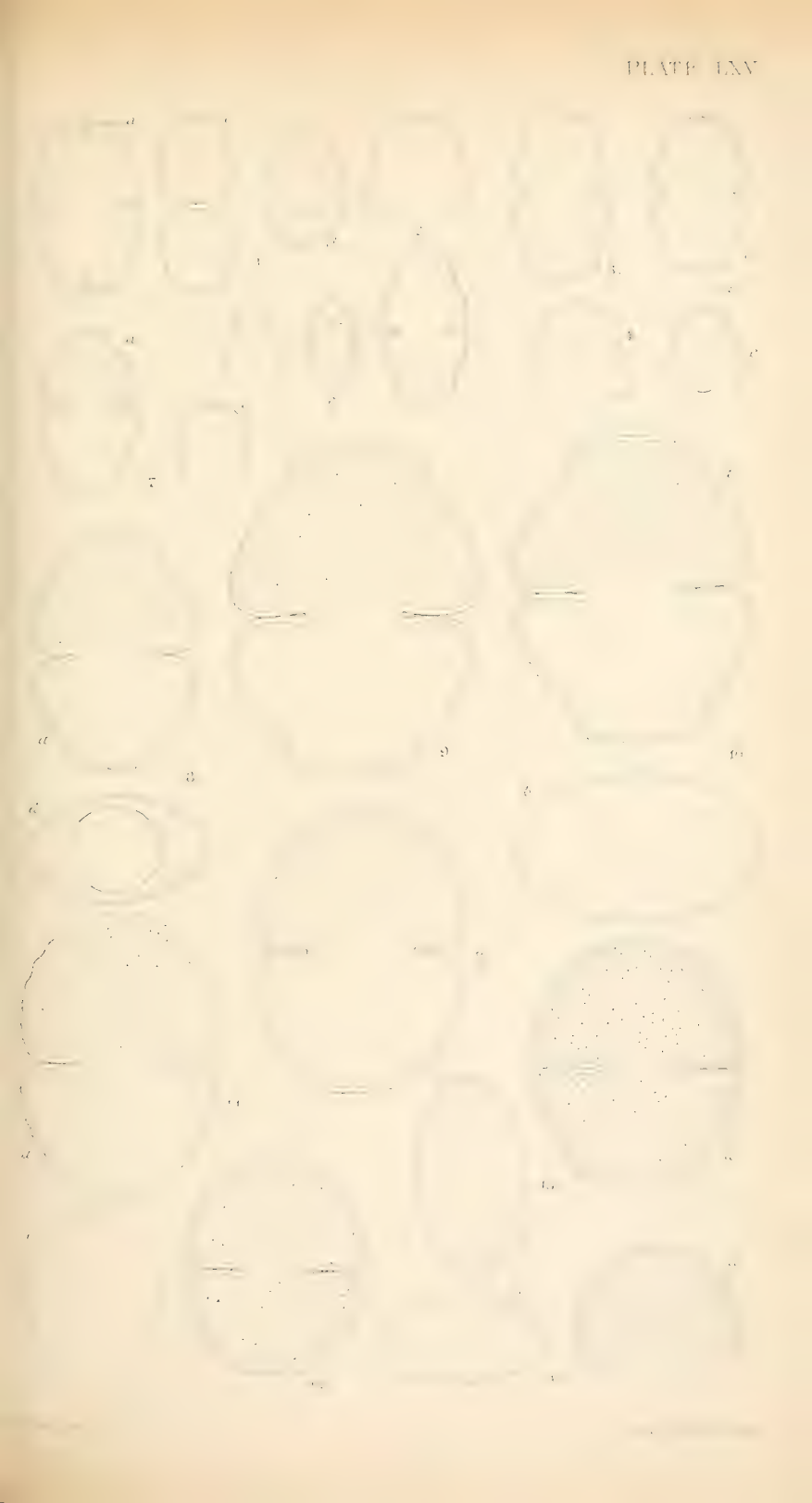
13–14.	—*C. obtusatum* Schmidle. 13, × about 625 (after Schmidle); 14, × 520	7
15.	—*C. obtusatum* var. *Beanlandii* West & G. S. West. × 520	8



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5–6.	—*C. venustum* var. *hypohexagonum* West. × 400	10
7–8.	—*C. Garrolense* Roy & Biss. 7, × 600 (after Roy & Bissett); 8, × 520	12
9–10.	—*C. Reinschii* Arch. 9, × about 750 (after Reinsch); 10, form with rounded apical angles, × 520	12
11.	—*C. Reinschii* var. *eboracense* West & G. S. West. × 500	13
12.	—*C. Nägelianum* Bréb. × 600 (after Nägeli)	14
13–14.	—*C. orthogonum* Delp. × 416 (after Delponte)	118
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PLATE LXVII.

FIGS. PAGE

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5.—*C. moniliforme* var. *subpyriforme* West & G. S. West. × 520 23

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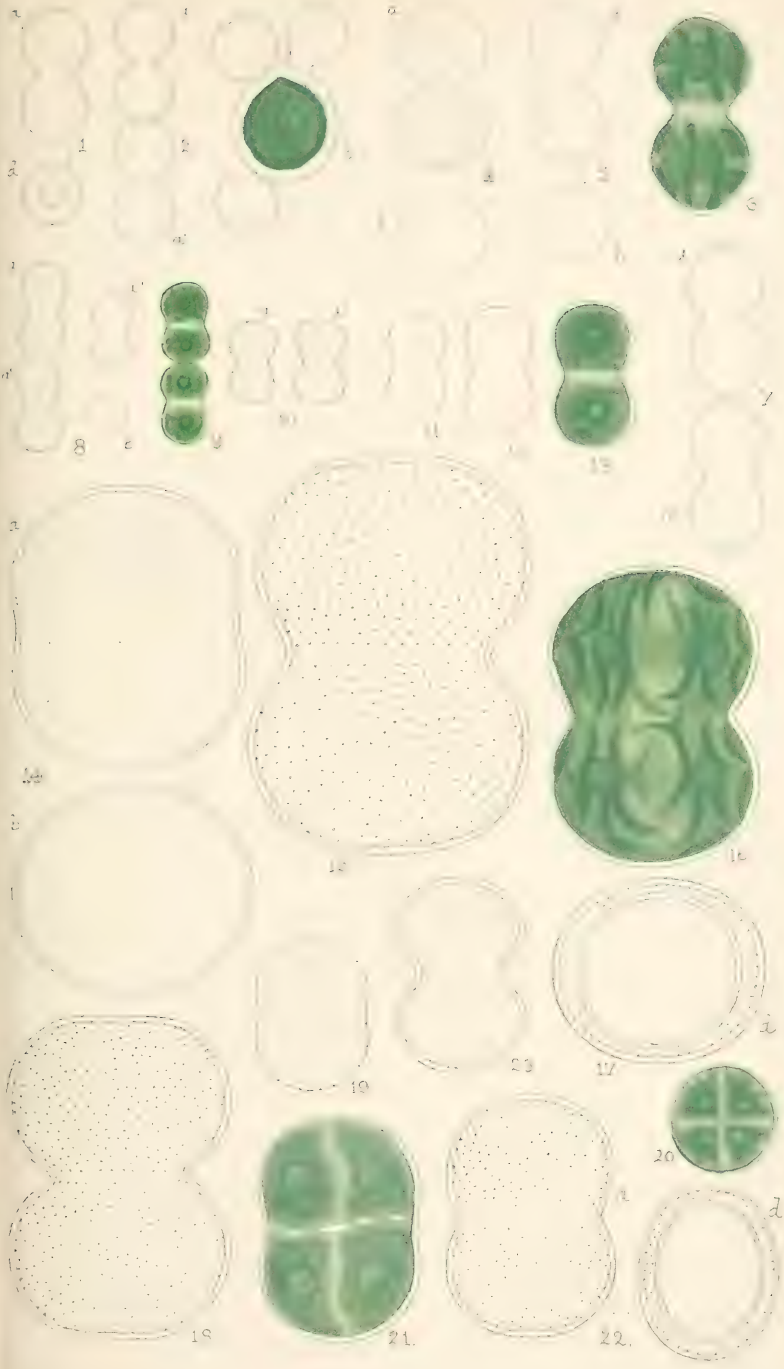

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6–8.	—*C. subarctoum* (Lagerh.) Racib. 6, × about 550 (after Raciborski); 7 and 8, × 520	31
9.	—*C. subarctoum* forma *punctata*. × 520	32
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11.	—*C. pericymatium* var. *eboracense* West & G. S. West. × 520	34
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14–17.—	*C. anceps* Lund. 14, × 400 (after Lundell); 15 and 16, × 500; 17, × 520	47
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25–27.—	*C. Norimbergense* Reinsch. 25 and 26, × about 1500 (after Reinsch); 27, × 520	52
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30.—	*C. repandum* Nordst. × 570 (after Nordstedt)	53
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PLATE LXX.

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6–8.—*C. quadratum* Ralfs. 6, × 400 (after Ralfs); 7, × 500; 8, × 520. Ralfs' figure of which we give a copy (fig. 6) is not a good one; the constriction is too deep. Figs. 7 and 8 are much more representative. [Compare Pl. LXXXVII, fig. 19.] . . 57

9–10.—*C. plicatum* Reinsch. × about 640 (after Reinsch) 60

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3–4.	—*C. pusillum* (Bréb.) Arch. 3, × 520; 4, × 1000	66
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10.	—*C. protuberans* forma *paludosa* W. & G. S. West. × 520	70
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36–37.	—*C. bireme* Nordst. 36, × 570 (after Nordstedt); 37, × 520	77
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PLATE LXXII.

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12.—*C. abbreviatum* forma *minor*. × 520 . 85

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19–21.—*C. umbilicatum* Lütkem. 19, × 1000 (after Lütkemüller); 20, × 500; 21, × 1000 . 88

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39.—*C. obliquum* Nordst. forma *major* Nordst. × 500 51

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G.S.West del.

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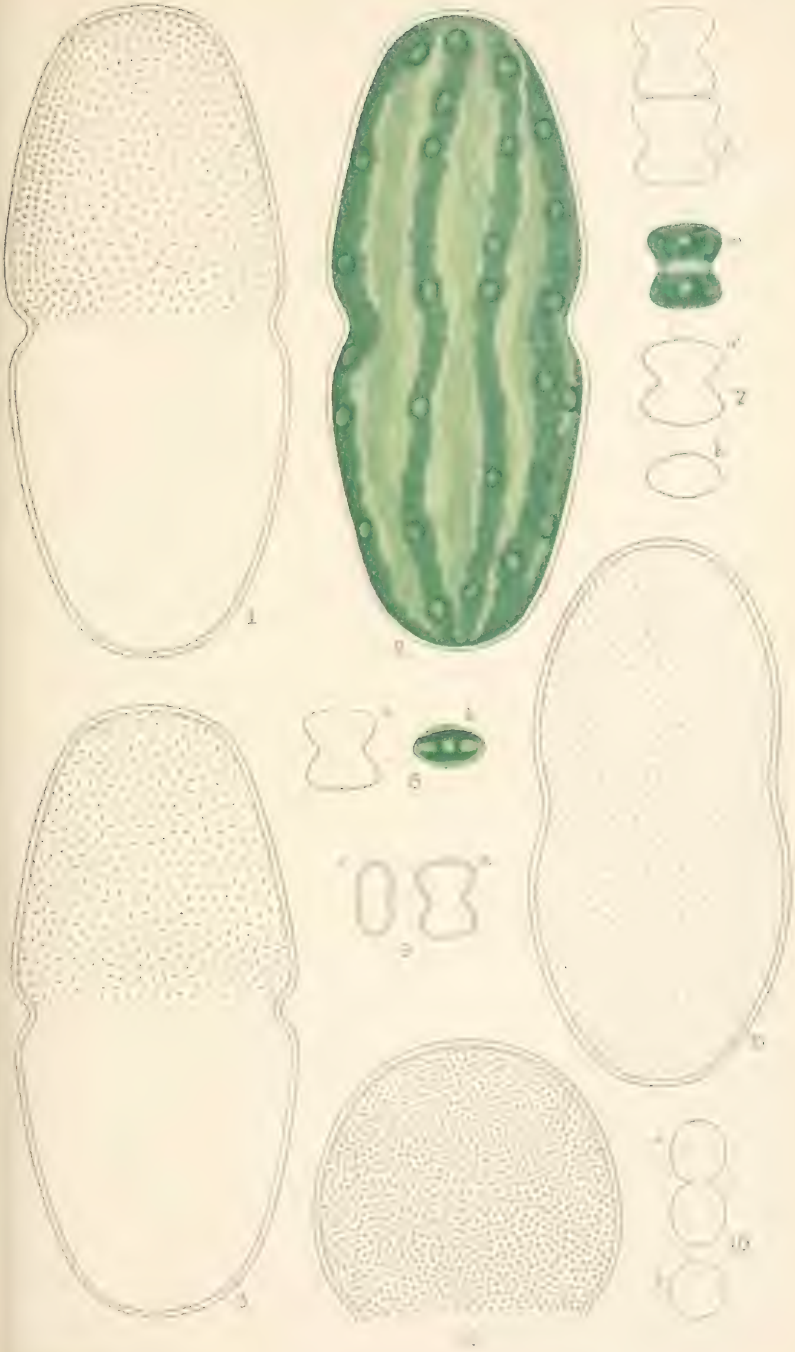

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1.—*Cosmarium Corriense* Bissett. × 400 (after Roy & Bissett) . . . 133

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PLATE LXXVII.

FIGS. PAGE

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1–10.—*Cosmarium ornatum* Ralfs. 1–9, × 500; 10, × about 300 (after Ralfs).

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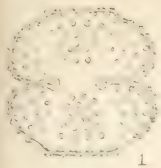
19.—*C. Wittrockii* Lund. × 400 (after Lundell) . 179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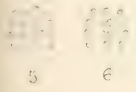
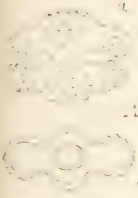

5 6 7 8

b 4

a 9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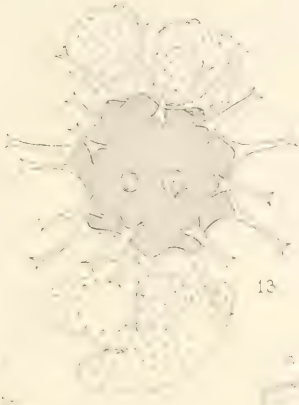
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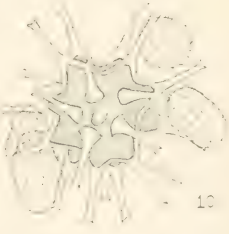
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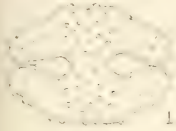
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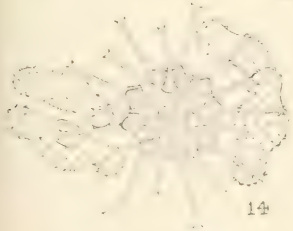
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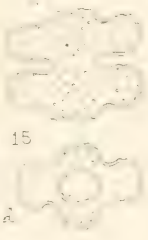
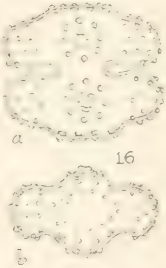
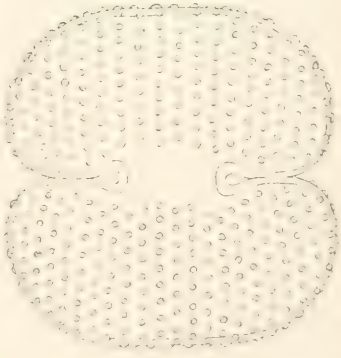

15 d


a 16 b

a 17 b

19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b
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1–2.—*Cosmarium Logiense* Biss. 1, × 400 (after Roy & Bissett); 2, × 500 . . 163

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4–7.—*C. Portianum* Arch. 4 and 5, typical Irish examples, × 500, showing the general disposition of the granules in vertical series . 165

Figs. 6 and 7 are after Schmidle's figures of "var. *orthostichum* Schmidle"; 6, × rather less than 600; 7, × 600–700 (Schmidle says between 700 and 800, but this is incorrect if compared with his stated dimensions). We see no reason for regarding the "var. *orthostichum*" as anything different from the typical plant. Schmidle's two figures differ more from each other than either differs from the common Irish form of *C. Portianum* first observed by Archer.

8.—Zygospore stated by Wolle to belong to *C. Portianum*, but undoubtedly that of some other *Cosmarium*. × 500 (after Wolle).

9.—Zygospore of "*C. Pseudomargaritiferum* Reinsch," a species which Archer has stated to be synonymous with his *C. Portianum*. × 720 (after Reinsch). It is probably an immature zygospore which has not yet developed the conical warts.

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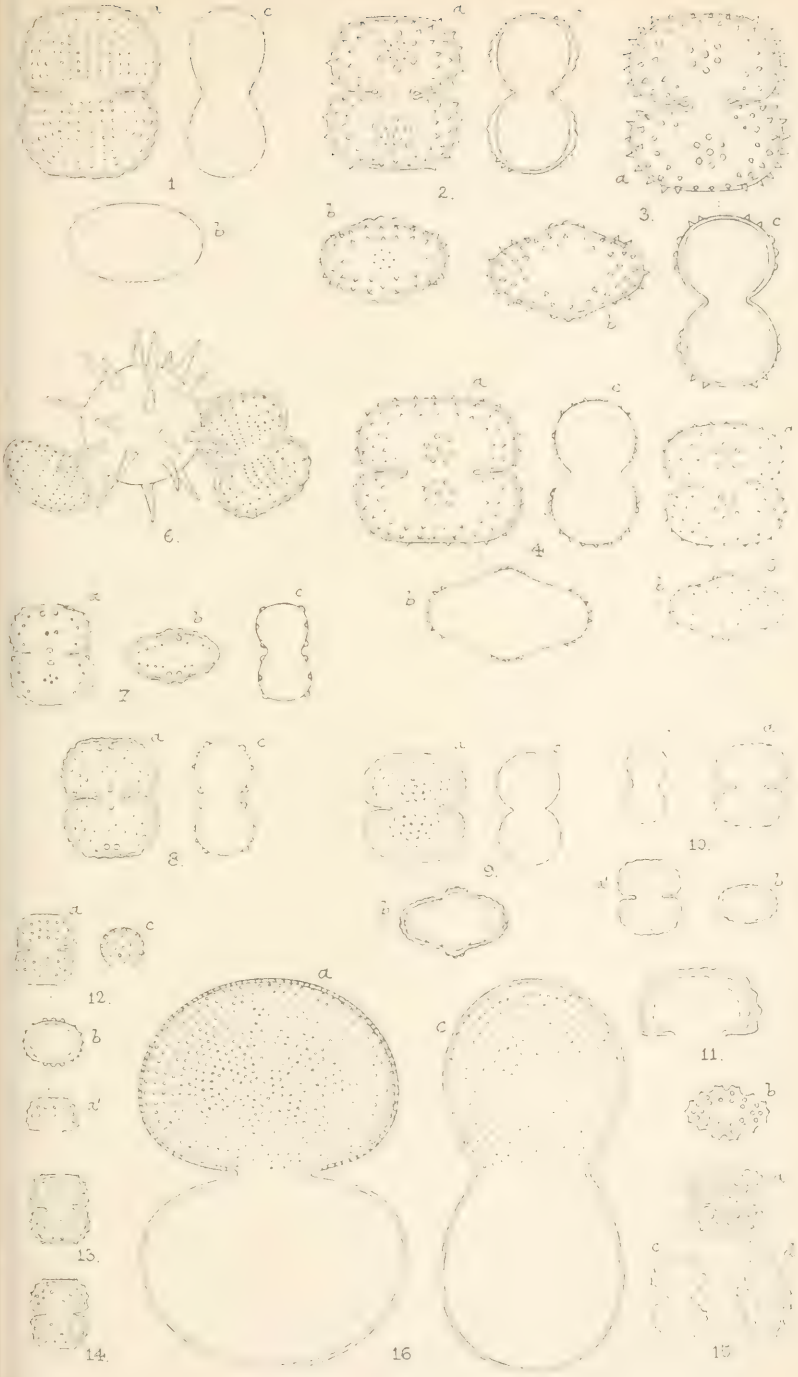
This figure is a copy of the one given by De Notaris, but we think the side view is incorrect, the constriction not being sufficiently deep.



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5–7.	—*C. synthlibomenum* West. 5 and 6, × 625; 7, × 1000	180
8.	—*C. protractum* (Näg.) De Bary. × 500. [Consult Pl. XCIV, figs. 4–5.]	181
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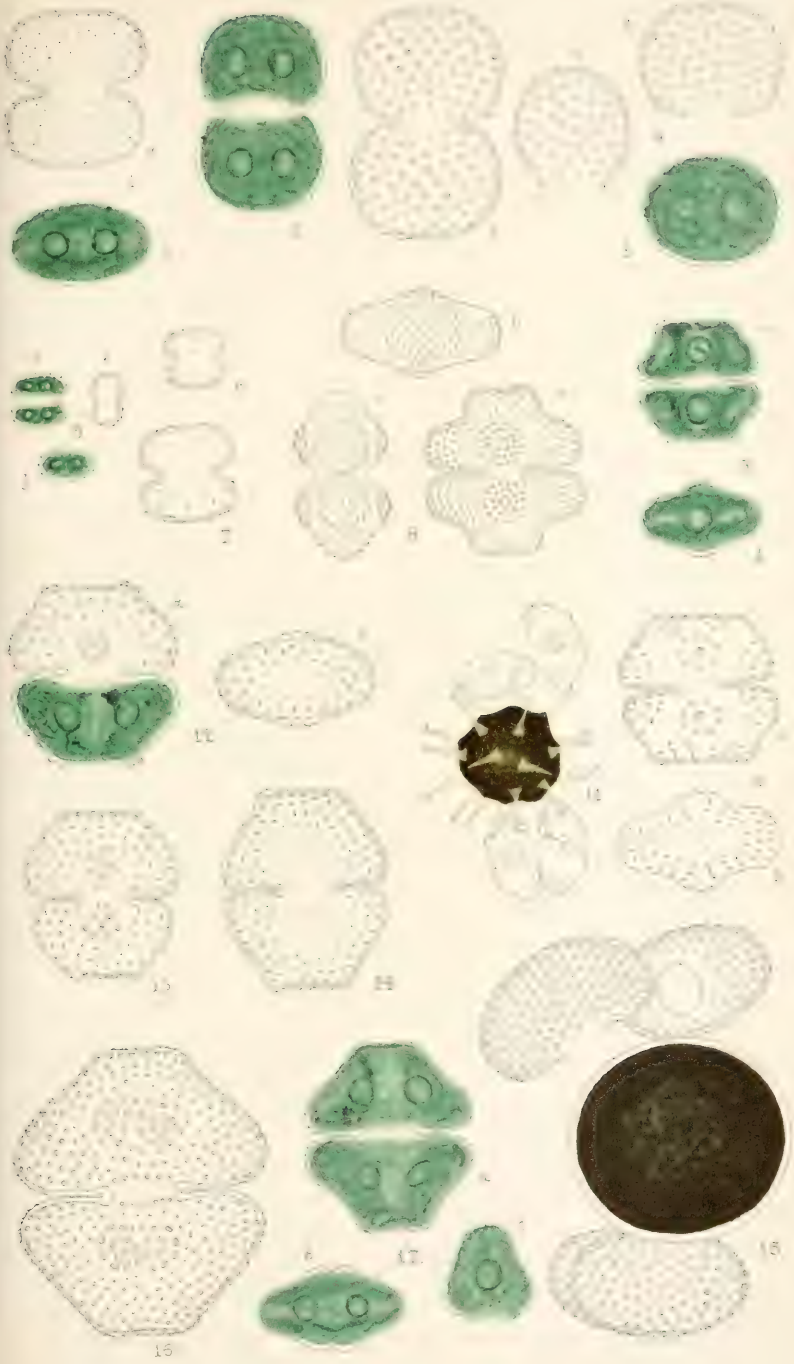

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1.—*Cosmarium Turpinii* Bréb. Vertical view, × 500 189

2.—*C. Turpinii* var. *podolicum* Gutw. × 500 . 191

3.—*C. Turpinii* var. *eximium* W. & G. S. West. × 500 192

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The cell-wall is minutely punctulate between the granules, but these punctulations are not well shown in the figures.

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13.—*C. margaritiferum* forma *Kirchneri* (Börges.) nob. *a* and *b*, × about 660; *a'*, × about 190 (after Börgesen) . . . 203

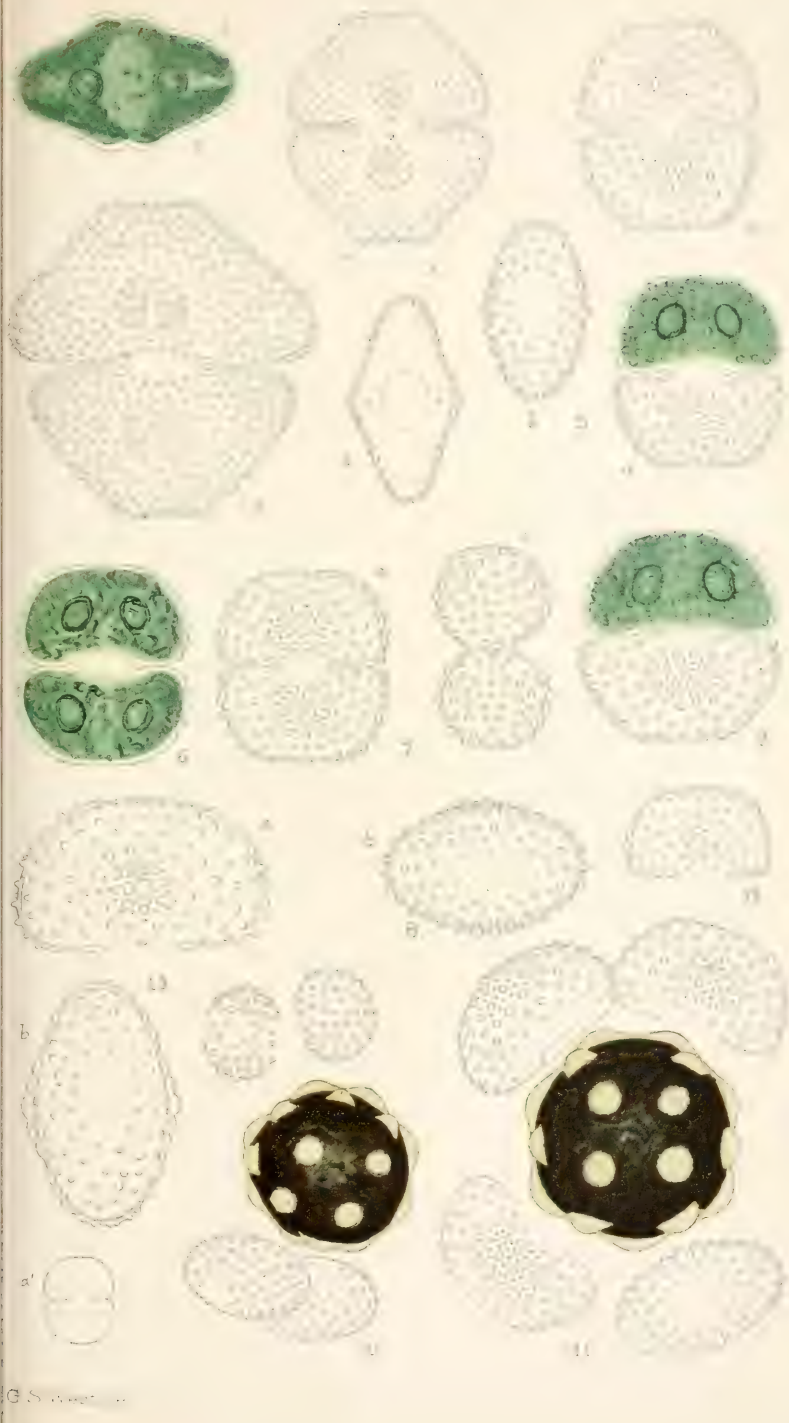

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PLATE LXXXIV.

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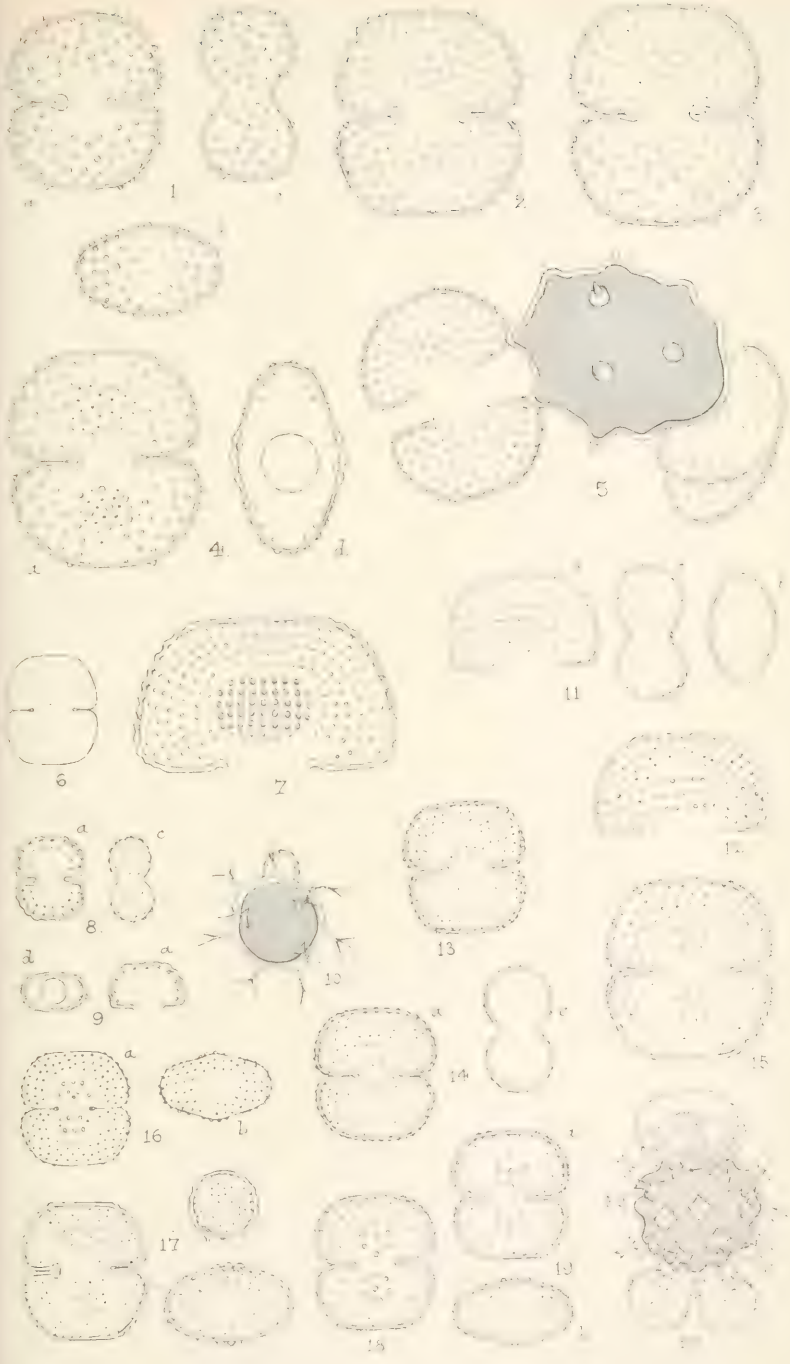

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4.	—*C. punctulatum* var. *granulusculum* (Roy & Biss.) nob. × 400 (after Roy & Bissett)	212
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16–18.	—*C. humile* (Gay) Nordst. × 1000	221
19.	—*C. humile* var. *danicum* (Börges.) Schmidle. × about 610 (after Börgesen)	224
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22.—*C. subprotumidum* forma. × 625 . . 232

23–25.—*C. subprotumidum* var. *Gregorii* (Roy & Biss.) West & G. S. West. 23, × 600 (after Roy & Bissett); 24, × 1000; 25, a form described by Gutwinski as "*C. Gregorii* var. *papilliferum* Gutw.," × 1030 (after Gutwinski) . 232

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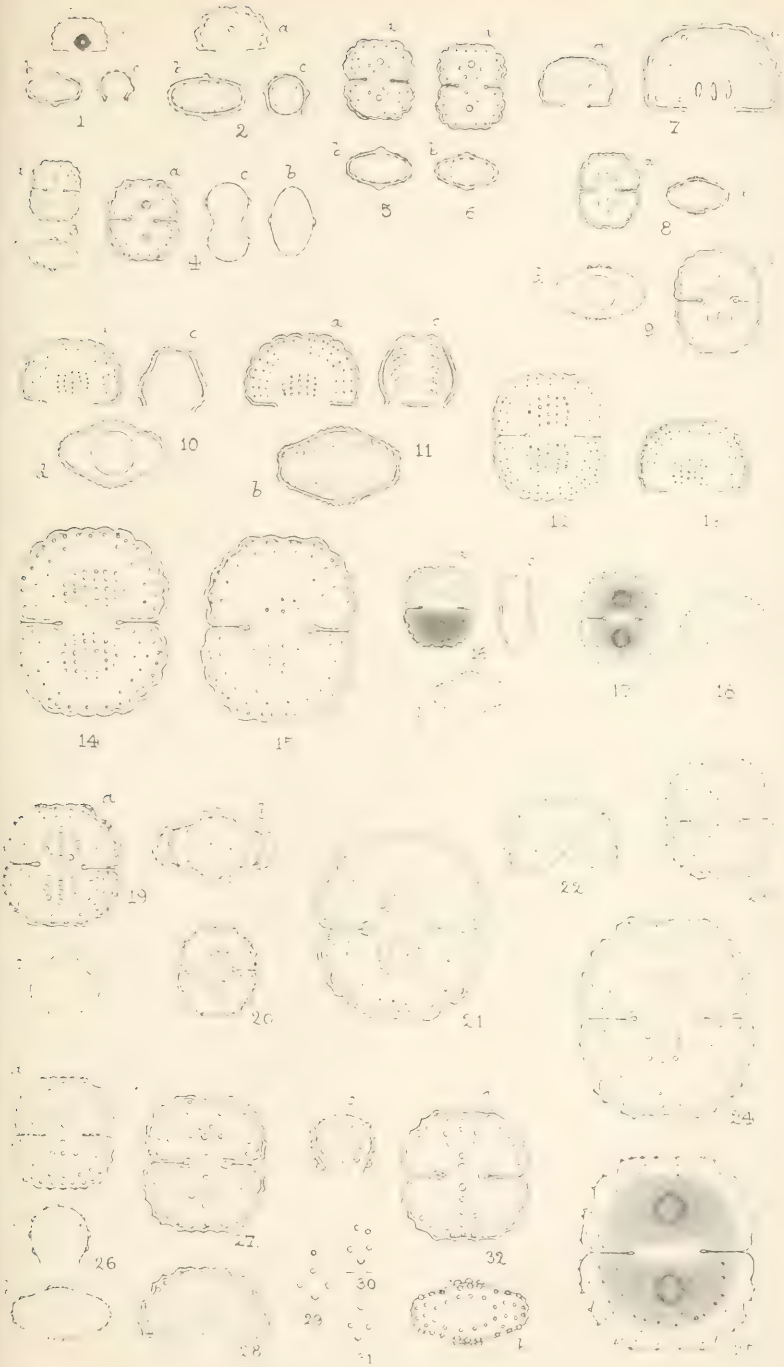

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PLATE LXXXVII.

FIGS. PAGE

1–2.—*Cosmarium calcareum* Wittr. 1, × 400 (after Wittrock); 2, × 400. The lower semicell of fig. 1*a*, which was unfinished in Wittrock's figure, has been utilized to show the single pyrenoid in the axile chloroplast . . 235

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4–5.—*C. formosulum* var. *Nathorstii* (Boldt) West & G. S. West. 4, × 550 (after Boldt); 5, × 550 242

Fig. 4*b* is a copy of Boldt's figure of the vertical view, but we think it slightly incorrect. The granules in the centre should not be so strongly marked. In the specimens we have examined they were scarcely discernible. The granules are likewise not shown on the median inflations.

6.—*C. subreniforme* Nordst. × 570 (after Nordstedt) 243

7.—*C. pycnochondrum* Nordst. × 570 (after Nordstedt) 244

8.—*C. didymoprotupsum* West & G. S. West. × 500 192

9.—*C. pulcherrimum* Nordst. × 570 (after Nordstedt) 245

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Fig. 12 is a copy of *C. binum* "var." Racib. (1889). It will be observed in the specimens figured that the number of marginal crenations is variable, the fewest number being exhibited by fig. 14.

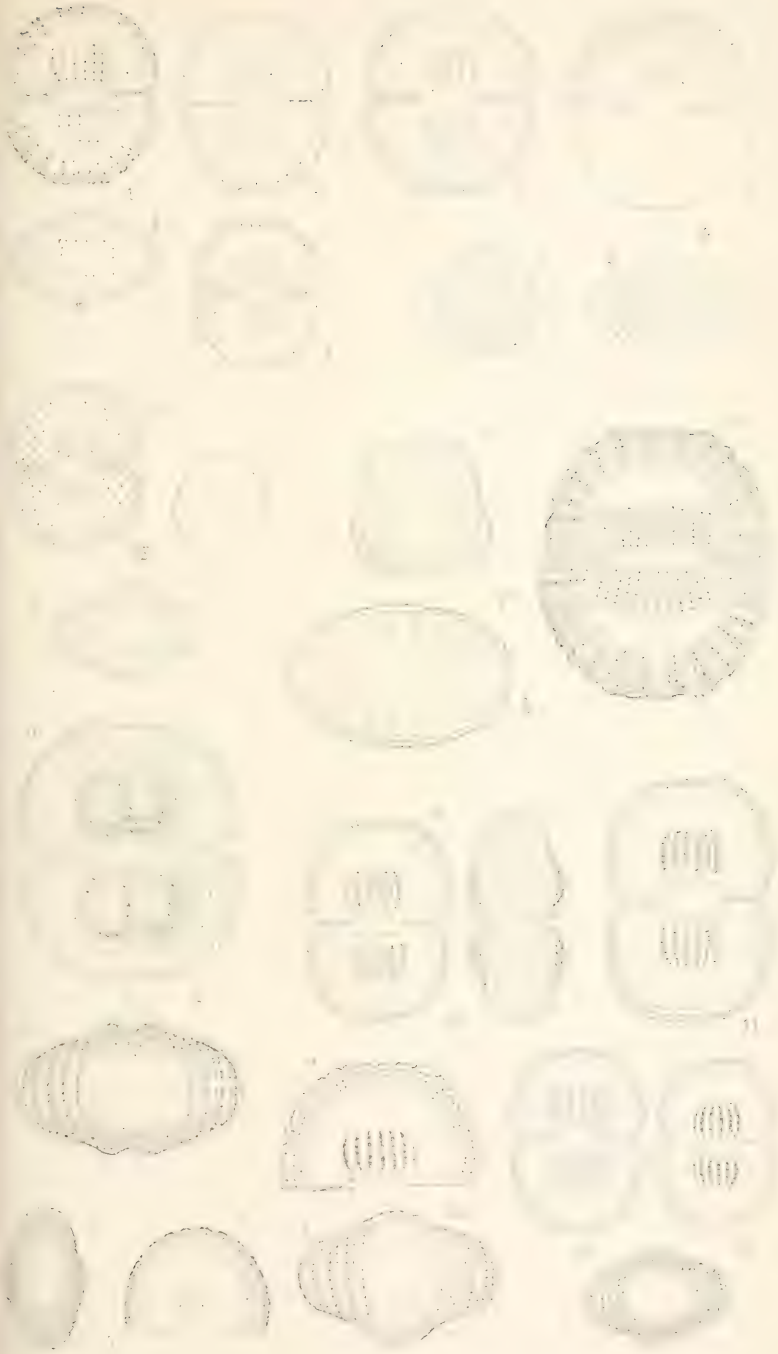

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PLATE LXXXIX.

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1–3.—*Cosmarium speciosum* Lund. 1, × 400 (after Lundell); 2, × 400; 3, × 500 . . 247

4–5.—*C. speciosum* var. *biforme* Nordst. 4, × 570 (after Nordstedt); 5, × 500 . . 249

6.—*C. speciosum* var. *simplex* Nordst. × 570 (after Nordstedt) 250

7.—*C. speciosum* var. *simplex* Nordst. forma *intermedia* Wille. × 400 (after Wille). . 251

8–10.—*C. speciosum* var. *Rostafinskii* (Gutw.) West & G. S. West. 8, × about 520 (after Gutwinski); 9, × 625; 10, × 400 . . . 251

In the lower semicell of fig. 8 the marks on the cell-wall are omitted and the small circle represents the position of the single pyrenoid.

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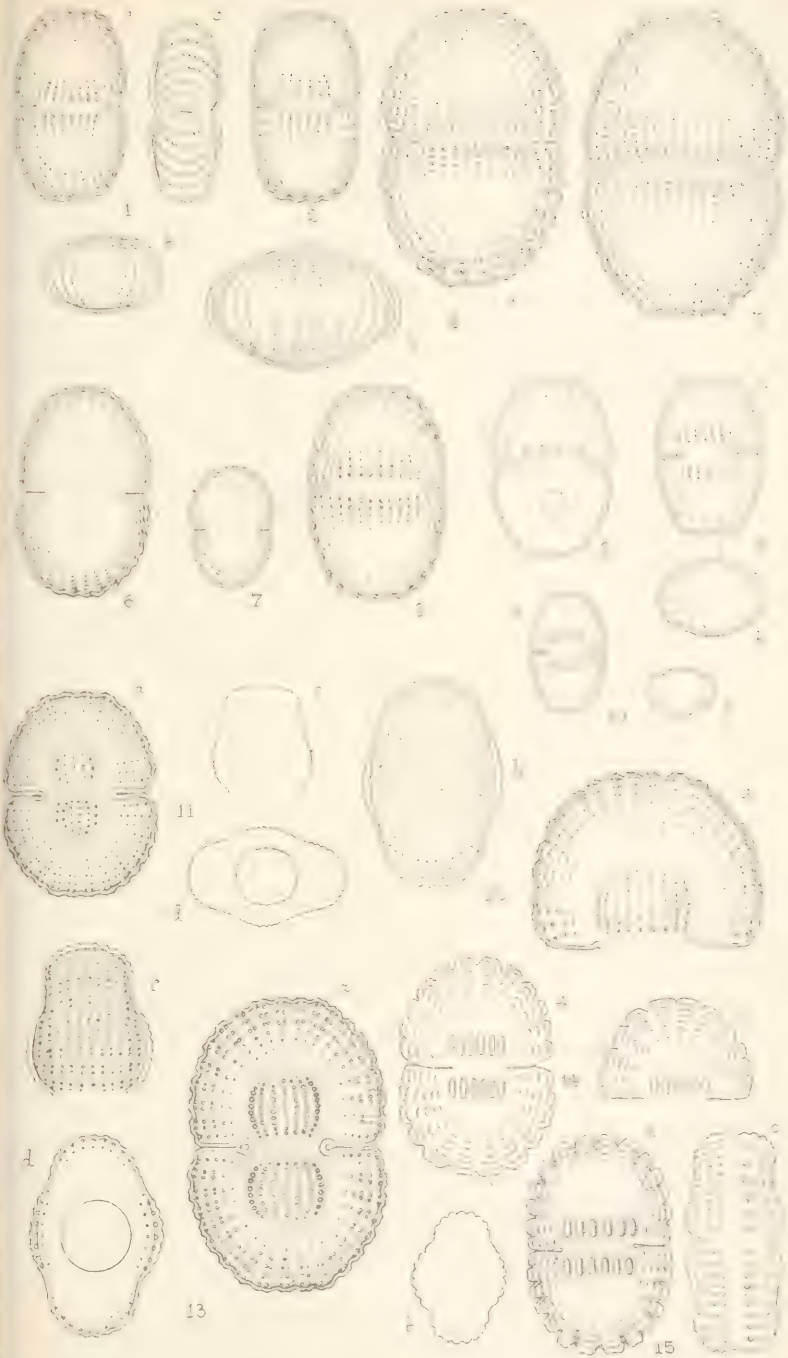

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PLATE XC.

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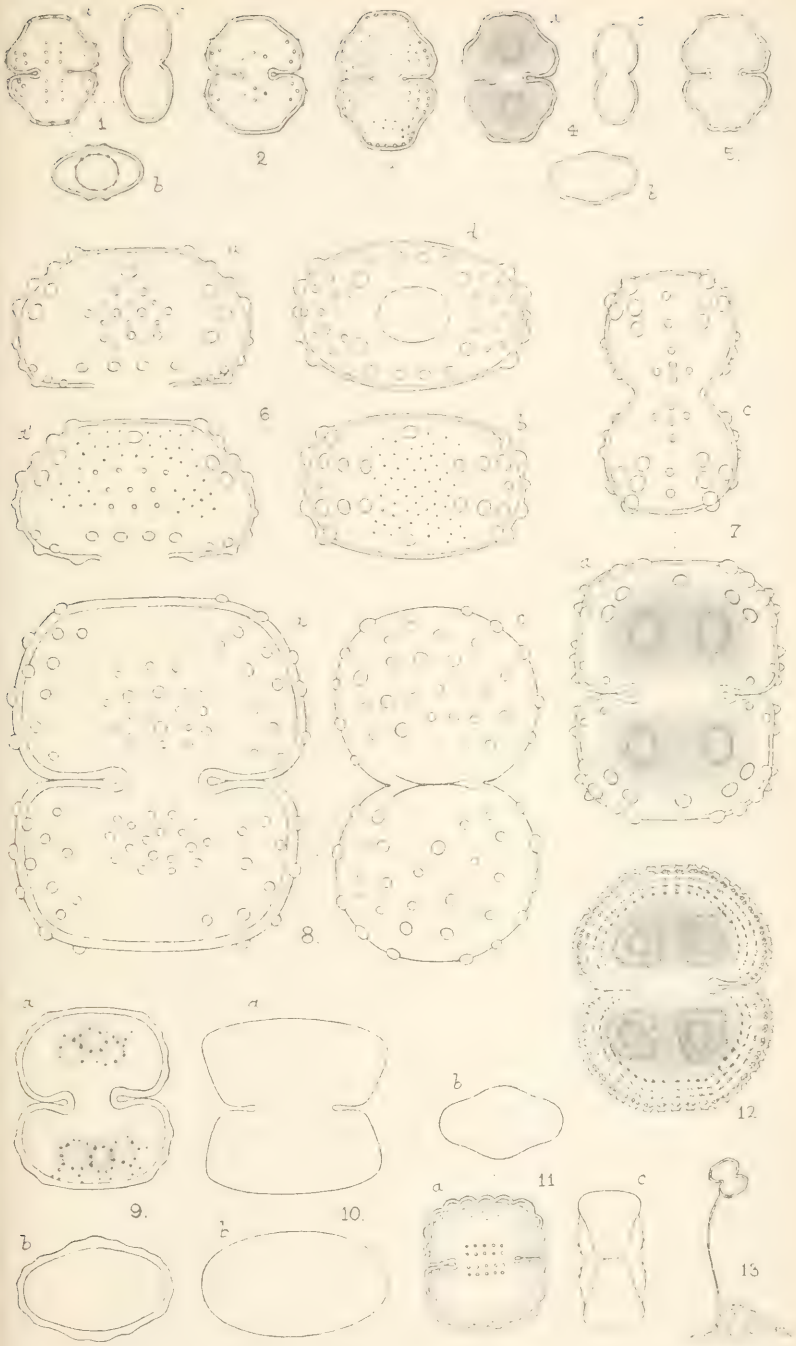

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FIGS. PAGE

1.—*Cosmarium ovale* Ralfs. × 520. [Consult Pl. XCIII, fig. 1, and Pl. XCIV, fig. 1.] . 267

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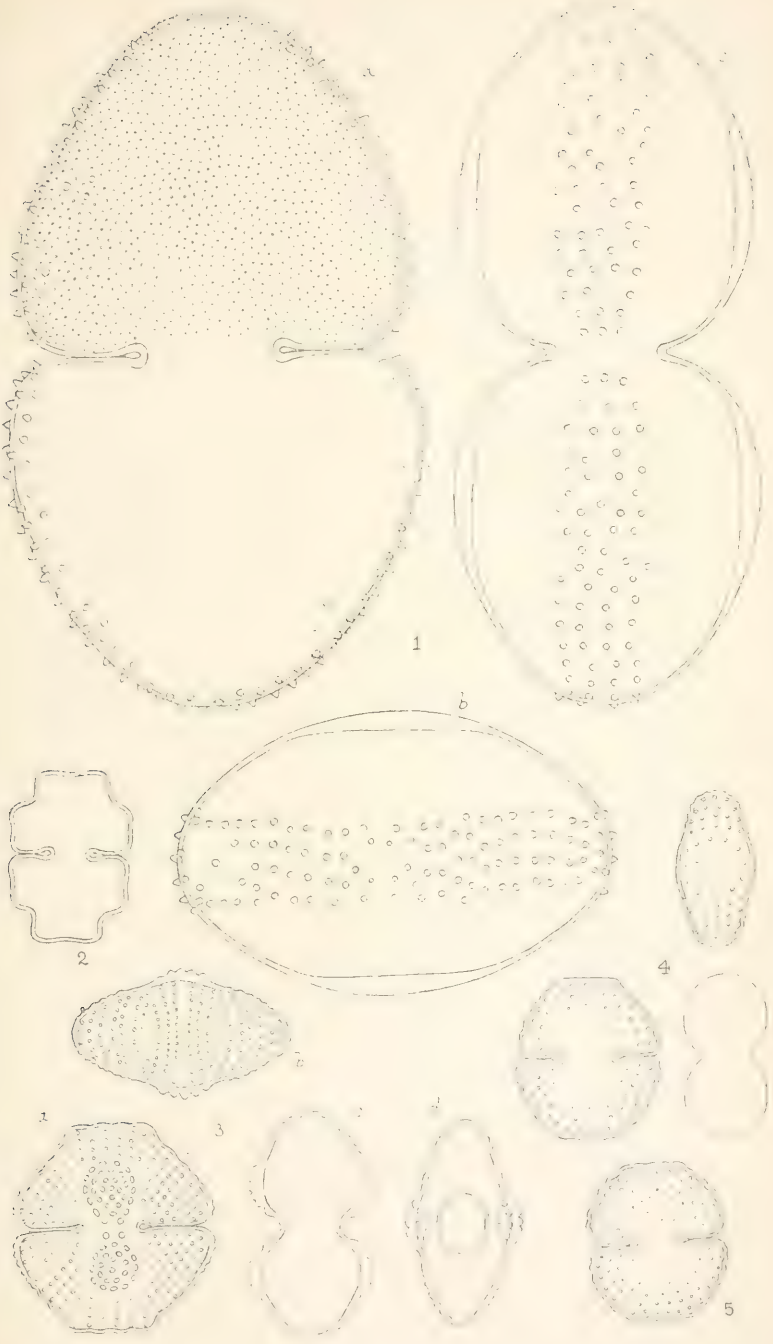

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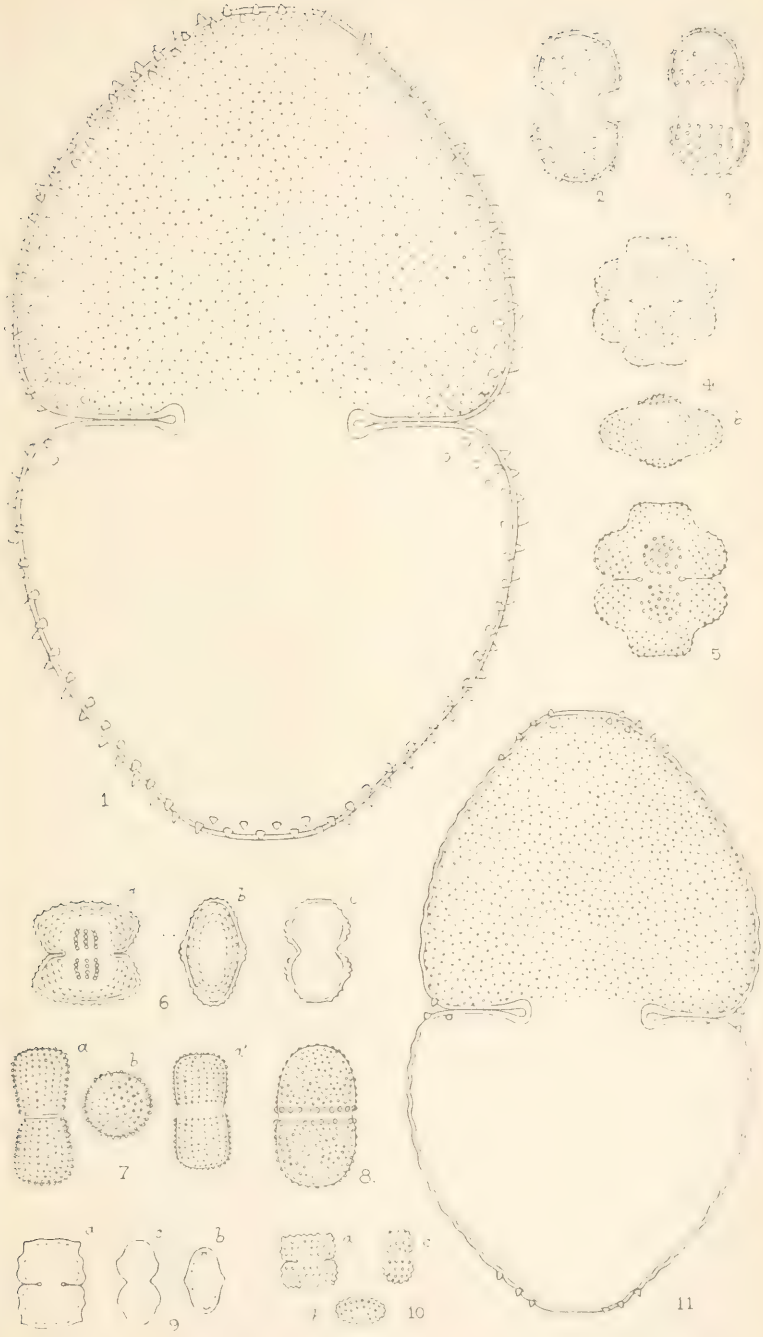
7.—*C. cylindricum* Ralfs. *a* and *b*, × 400 (after Ralfs); *a'*, × 400. Description in the next volume.

8.—*C. subcylindricum* West. × 520. Description in the next volume.

9.—*C. promontorium* West & G. S. West. × 520. Description in the next volume.

10.—*C. lepidum* West. × 400. Description in the next volume.

11.—*C. ovale* Ralfs var. *subglabrum*. West & G. S. West. × 520 269



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FIGS. PAGE

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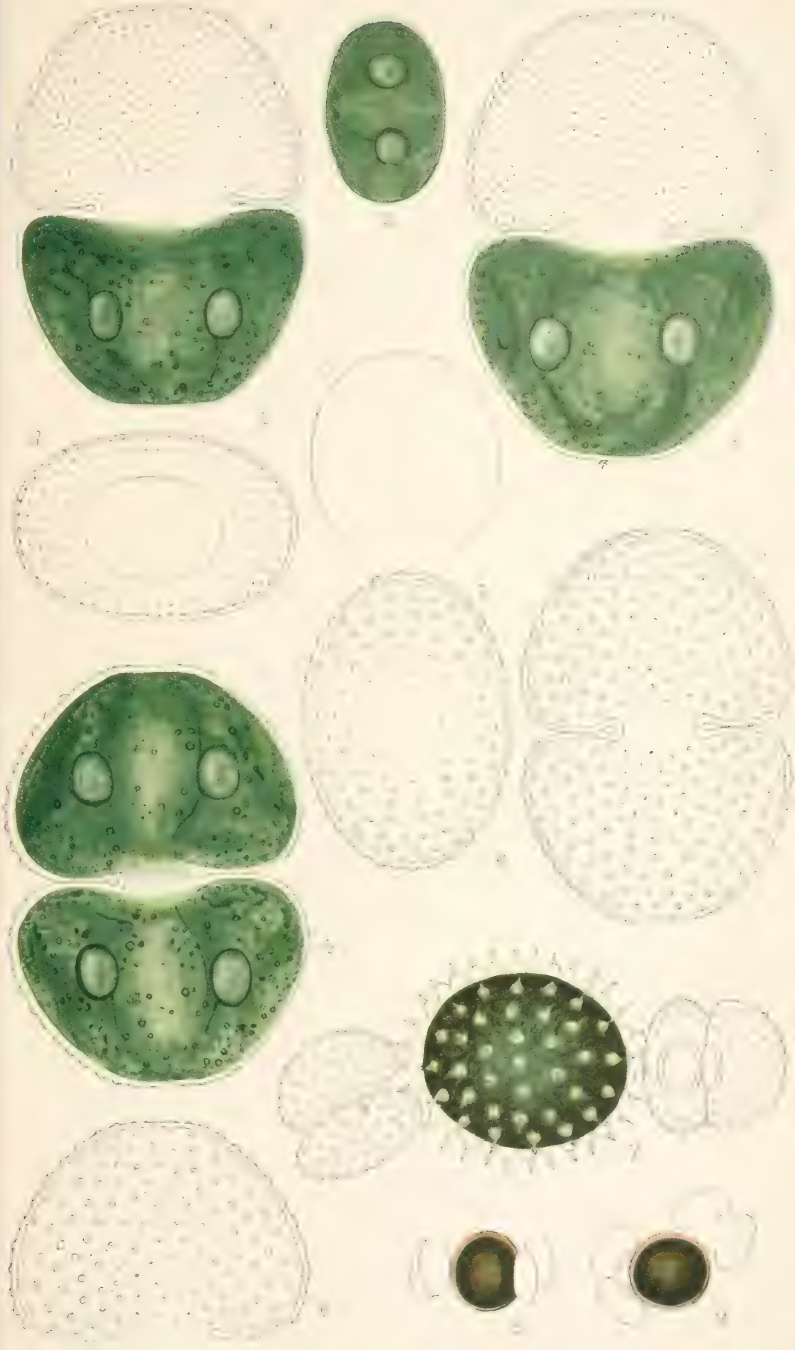

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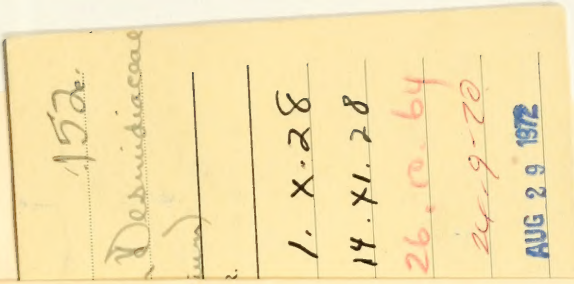

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